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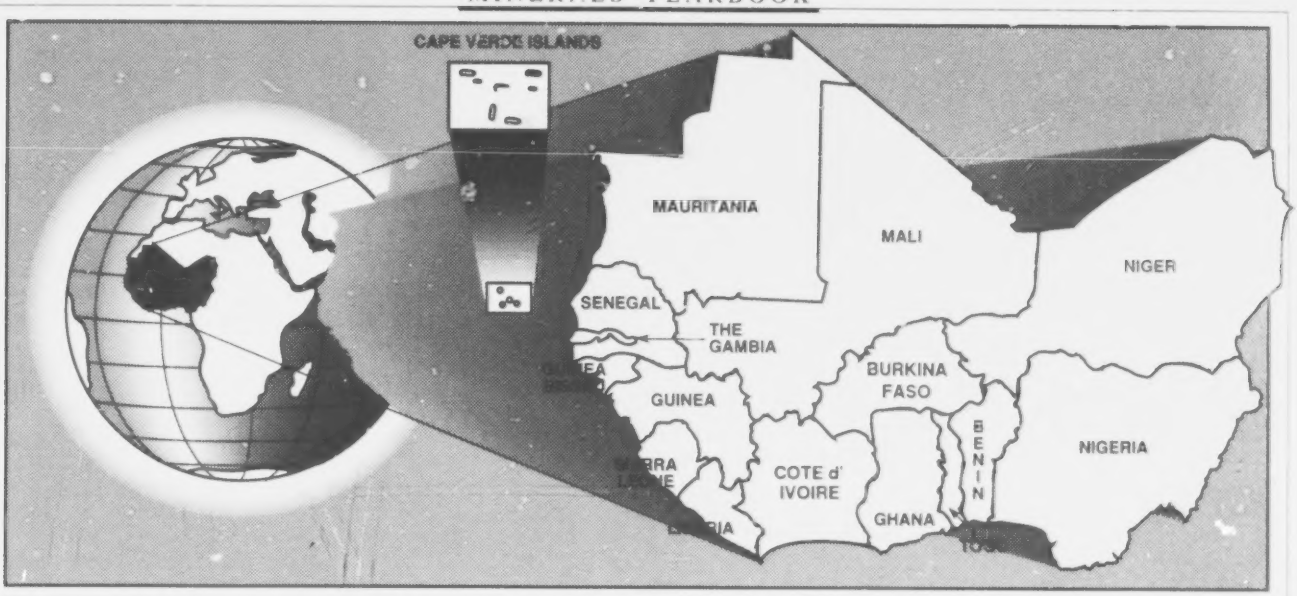

THE MINERAL INDUSTRIES OF

WEST AFRICA

By Hendrik G. van Oss and Bernadette Michalski

1988

INTERNATIONAL REVIEW

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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WEST AFRICA

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1988

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THE MINERAL INDUSTRIES OF

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BENIN[1]

Benin's economy was hurt by low world prices for petroleum, the country's dominant mineral product. Benin also produced a modest amount of cement and a small amount of salt, as well as undocumented quantities of sand and gravel for local consumption. Early in 1988, operations began at the 62 megawatt hydroelectric plant at Nagbeto, at the Togolese border. It was expected that this development would significantly reduce the country's reliance on imported electricity, largely from Ghana.

Production of crude oil fell almost 10% in 1988. While 1988 export revenues for petroleum were not available, they amounted to $18.4 million[2] in 1987, approximately 28% of the country's total export revenues. Benin remained totally dependent upon imported petroleum products; these amounted to $25.6 million in 1987, equivalent to 21% of the country's total imports. This level of petroleum product imports, a 37% decline from 1986, reflected a resurgence of informal imports from Nigeria that resulted from the 1986 reopening of the Benin-Nigeria border. A significant portion of Benin's petroleum product imports were re-exported to neighboring countries. Approximately 14% of the 1987 imports were so traded.

At the end of April, Ashland Exploration of the United States signed a 2-year agreement with the Government to assume the operation of the Semé oilfield. The company announced that it would proceed with the existing Phase II plans for further developing the field. At least four new wells were to be drilled, and were expected to be on-line within 2 years. With production from the new wells, it was anticipated that output from the Séme oilfield would rise to 8,000 barrels per day. Funding for this drilling would be from existing World Bank and European Investment Bank loans that had been frozen in early 1986 pending resolution of management problems with the field's previous operators.

Trilogy Resources Co. of Canada was granted 100% interest in a 2.27 million acre onshore oil exploration concession, which was the first such concession to be granted since 1977. Exploration was planned for 1989. The Soviet Union was conducting petroleum exploration over a 6,000-square-kilometer area in the northwest part of the country.

In 1988, American entrepreneur John Moore, following the success of a similar venture set up in Togo in 1984, established a steel mill in Cotonou under the name Société Béninoise de Sidérurgie. The mill was to produce rebar, cotton-baling wire, and corrugated sheet roofing iron. The local market was estimated to be able to support an output of 7,000 tons per year, and there was considered to be some potential for exports to Nigeria and Burkina Faso. Production was expected toward yearend.

The Government was seeking private management for the three cement plants operated by the State-owned Société des Ciments d'Onigbolo. The plants had experienced losses resulting from continued production at levels well below capacity.

BURKINA FASO[3]

In 1988, the mineral industry of Burkina Faso continued to be largely underdeveloped, and was dominated by the production of gold. The country had reserves of several other commodities, notably manganese and base metals, but these remained undeveloped because of infrastructure and funding problems.

Much of the country's gold output was unreported artisanal production, new estimates of which suggest that the country's gold output in 1987 was almost triple earlier estimates, and further increased by about 50% in 1988. Legal sales of gold production were estimated to amount to about $45 million, or almost 20% of the country's total exports.[4] However, revenues from smuggled artisanal gold production were estimated to amount to an additional $80 to $90 million.

A railroad from Ougadougou to Kaya was under construction during the year. Kaya is the halfway point to the large manganese deposit at Tambao, development of which has been stymied by the lack of infrastructure.

Commodity Review

Metals.—**Gold.**—The largest single producer of gold in the country was the Poura gold mine, operated by the Société de Recherches et d'Exploitation Minières du Burkina (SOREMIB). SOREMIB was a joint venture of the Government (60%), the Islamic Development Bank (20%), and Compagnie Française des Mines (Coframines), a subsidiary of France's Bureau de Recherches Géologiques et Minières (BRGM). Production from the mine in 1988 was 73,882 troy ounces and sales were 74,815 ounces. Production was affected by a cave-in of the inclined shafts in early December. It was expected that this would lead to reduced gold production in 1989 and severe financial difficulties for the company. Coframines provided technical services to the mine during the year, but reportedly SOREMIB was seeking to reduce Coframines' involvement in these services.

Early in the year, the Société Minière Coréo-Burkinabé (SOMICOB) was reported to be producing about 1,600 troy ounces per month from a small placer operation at Sebba. However, owing to an inadequate sampling program prior to mining, reserves were exhausted within a few months. SOMICOB was a joint venture between the Government (60%) and North Korea.

Artisanal gold mining was widespread in Burkina Faso, and it was

estimated that as many as 75,000 workers were employed on a seasonal basis in this activity. The bulk of the gold production was smuggled out of the country, largely to Côte d'Ivoire, Togo, and Mali. The Government, the sole legal channel for gold sales, was offering only about 50% of the world bullion price for the artisanal production and managed to purchase only about 32,000 troy ounces of this output. It was felt that this represented only about 15% of the total artisanal production.

Zinc.—Toward yearend, Boliden Mineral AB of Sweden met with the Bureau des Mines et de la Géologie du Burkina to discuss the possibility of Boliden evaluating the Perkoa zinc-silver deposit, believed to contain reserves of at least 5 million tons of ore grading in excess of 18% zinc and about 2 troy ounces per ton silver. The deposit is located about 30 kilometers from the rail line linking Ougadougou with Abidjan, Côte d'Ivoire.

CAPE VERDE ISLANDS[5]

The minerals industry of the Cape Verde Islands was limited to the production of small quantities of pozzolana, pumice, and salt, largely for domestic consumption. Some salt was exported. Plans for a 64,000-ton-per-year cement plant on Maio Island, initially approved in 1984, were shelved in 1988 by the Government because of low domestic demand and world prices for cement.

CÔTE D'IVOIRE[6]

Mineral production played a negligible role in the Côte d'Ivoire economy, which continued to be dominated by the production of cocoa and coffee. The country was a modest producer of petroleum and had minor artisanal production of diamonds and gold. There was, however, considerable exploration interest in gold.

Commodity Review

Metals.—**Gold.**—Gold mining in 1988 was restricted to artisanal production. Reported output fell to 178 troy ounces, but additional undocumented production was likely. As in years past, Côte d'Ivoire was an outlet for smuggled gold, largely from Burkina Faso. Estimates of the amount of gold smuggled through Côte d'Ivoire ranged as high as 6,500 troy ounces per week; however, gold exports were officially listed as 10,242 ounces for the year.

Côte d'Ivoire contains several Birrimian series greenstone belts. This geologic similarity to the country's gold-producing neighbors Burkina Faso, Ghana, and Mali, led to an increasing interest during the year in gold exploration. The parastatal Société pour le Développement Minier de la Côte d'Ivoire (SODEMI) conducted some of this exploration, commonly as a joint effort with foreign entities, notably the BRGM. The most advanced gold project continued to be the Ity deposit near the country's western border. The Ity deposit was undergoing final feasibility studies by Société des Mines d'Ity, owned 60% by SODEMI and 40% by Coframines. The deposit contained ore both within a laterite cap and in underlying clay-altered Birrimian rocks. Proven reserves were 700,000 tons of laterite ore grading 7 grams (0.23 ounce) of gold per ton and 1.2 million tons of argillaceous ore grading 9 grams (0.29 ounce) of gold per ton. Initial mining was planned to be by open pit extraction of the laterite ore, to produce 4.5 tons (145,000 ounces) of gold at a rate of 650 kilograms (21,000 ounces) of gold per year. Site preparation was expected to commence in late 1989.

Another advanced project was that of the Afema Syndicate, a joint venture of Eden Roc Mineral Corp. of Canada (49%) and SODEMI. The project was focused on the Asupiri shear zone near the southeast border with Ghana. In 1987, drilling to a depth of 262 meters had outlined probable reserves of about 2.35 million tons grading 6.2 grams (0.20 ounce) of gold per ton. Funding problems prevented further drill testing of the property in 1988, but these problems were resolved toward yearend, and it was expected that the testing would proceed in 1989.

Steel.—The Société Ivoirienne de Sidérurgie, a joint venture between U.S. investor John Moore (40%) and the Government (60%), was organized during the year under a World Bank export incentive program, to re-equip a bankrupt 20,000-ton-per-year, state-run steel mill. The company expected to produce steel fence posts for export to the United States and steel grinding balls for sale to gold mines in the region, particularly in Ghana, and to the Société Nationale Industrielle et Minière iron mines in Mauritania. Exports of both products were expected to begin in the second half of 1989.

Mineral Fuels.—Petroleum production fell significantly, owing to the progressive exhaustion of reserves at the country's two operating fields. In October, Phillips Petroleum announced that production from one of these, the Espoir Field, would cease at yearend.

THE GAMBIA[7]

There was no production of mineral commodities in The Gambia in 1988, except for limited undocumented quantities of clay and sand and gravel for local use. It was believed that the country's greatest potential for mineral resources development was in petroleum and in heavy minerals (titanium) sands. The Gambian titanium sand resource, an extension of a large deposit in Senegal, was estimated to contain 1 million tons of heavy minerals.

TABLE 1

WEST AFRICA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Country[1,2] and commodity[3]		1984	1985	1986	1987[p]	1988[e]
BENIN[4]						
Cement, hydraulic[e]		300,000	300,000	300,000	300,000	500,000
Petroleum, crude	thousand 42-gallon barrels	r2,600	r2,900	r2,800	e1,940	1,800
Salt, marine[e]		100	100	100	100	100
BURKINA FASO[4] (formerly Upper Volta)						
Gold[e]	troy ounces	r22,000	50,000	60,000	5r220,000	5340,000
Phosphate rock[e]	thousand tons	3	3	3	3	3
Stone, Marble[e]	thousand tons	50	100	100	100	100
Pumice and related volcanic materials[e]		10,000	10,000	10,000	10,000	10,000
Salt		6,500	6,500	6,500	6,500	6,500
CAPE VERDE ISLANDS[4]						
Pumice and related volcanic rock materials[e]		10,000	10,000	10,000	10,000	10,000
Salt[e]		6,500	6,500	6,500	6,500	6,500
CÔTE D'IVOIRE[4]						
Cement[6]	thousand metric tons	536	679	776	653	r700
Diamond[e,8]	carats	25,000	20,000	r13,600	21,000	r11,157
Gold	troy ounces	—	—	r161	218	r178
Petroleum:						
Crude	thousand 42-gallon barrels	r9,960	r8,060	r6,600	r6,200	r4,721
Refinery products:[e]						
Motor gasoline	do.	2,196	2,190	2,190	2,555	2,562
Kerosene and jet fuel	do.	3,294	3,285	3,285	3,285	3,294
Distillate fuel oil	do.	3,294	3,650	3,650	3,650	3,660
Residual fuel oil	do.	3,660	3,650	3,650	3,650	3,660
Liquefied petroleum gas	do.	350	350	350	350	350
Other	do.	366	365	365	365	366
Total	**do.**	**13,160**	**13,490**	**13,490**	**13,490**	**13,892**
GHANA[10]						
Aluminum:						
Bauxite, gross weight		44,000	170,000	226,000	r230,000	r299,939
Metal, smelter, primary		NA	48,550	124,570	r150,000	r161,392
Cement, hydraulic[6]	thousand metric tons	229	363	219	r274	r477
Diamond:						
Gem[e]	thousand carats	35	60	r84	r65	e165
Industrial[e]	do.	311	572	r438	r400	e495
Total	**do.**	**8346**	**8632**	**8522**	**8r465**	**11e660**
Gold	thousand troy ounces	287	299	287	r328	r373
Iron and steel: Steel, crude[e]		5,400	5,400	5,000	5,000	5,000
Manganese:						
Ore and concentrate, gross weight		r251,019	r318,665	304,351	r274,451	r259,614
Mn content		r94,800	r118,100	110,300	r97,900	96,600

See footnotes at end of table.

TABLE 1—Continued

WEST AFRICA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Country[1 2] and commodity[3]		1984	1985	1986	1987[p]	1988[e]
GHANA—Continued						
Petroleum:						
Crude[e]	thousand 42-gallon barrels	730	100	—	—	—
Refinery products:						
Gasoline	do.	1,460	e1,000	e1,000	e1,000	1,000
Jet fuel	do.	224	e200	e200	e200	200
Kerosene	do.	666	e600	e600	e600	600
Distillate fuel oil	do.	1,270	e1,000	e1,000	e1,000	1,000
Residual fuel oil	do.	2,120	e2,000	e2,000	e2,000	2,000
Other	do.	81	e80	e80	e80	80
Refinery fuel and losses	do.	216	e200	e200	e200	200
Total	**do.**	**6,037**	**e5,080**	**e5,080**	**e5,080**	**5,080**
Salt[e]		50,000	50,000	50,000	50,000	50,000
Silver, mine output, Ag content[e]	thousand troy ounces	14	14	14	16	18
GUINEA[12]						
Aluminum:						
Bauxite:						
Mine production:						
Wet basis	thousand metric tons	14,156	13,100	14,423	14,600	r16,868
Dry basis	do.	12,740	11,790	13,300	13,500	r15,619
Shipments (dry basis):						
Metallurgical-grade bauxite	do.	11,310	11,084	11,469	11,500	13,500
Calcined bauxite	do.	120	100	122	r138	r264
Alumina:						
Production	do.	578	572	556	556	r590
Shipments	do.	578	572	556	556	r590
Diamond:						
Gem	thousand carats	44	123	190	r163	136
Industrial	do.	3	9	14	r12	10
Total	**do.**	**47**	**132**	**204**	**175**	**e146**
Gold	troy ounces	—	—	—	—	e,13,42,500
LIBERIA[14]						
Cement, hydraulic	thousand metric tons	84	95	97	90	r106
Diamond: [e]						
Gem	thousand carats	108	66	63	60	67
Industrial	do.	132	72	189	190	100
Total	**do.**	**240**	**138**	**252**	**250**	**e167**
Gold[e]	troy ounces	15,10,500	15,4,900	15,20,100	15,000	r,8,21,753
Iron ore	thousand metric tons	15,100	15,318	15,295	13,742	r12,767
MALI[4]						
Cement, hydraulic		25,365	19,005	20,000	22,000	25,000
Gold, mine output, Au content[e 16]	troy ounces	r16,000	r18,000	16,000	22,500	r85,200
Phosphate rock[e]		r3,460	r7,047	3,452	8,092	10,000
Salt[e]		4,500	4,500	4,500	4,500	4,500

See footnotes at end of table.

TABLE 1—Continued

WEST AFRICA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Country[1,2] and commodity[3]		1984	1985	1986	1987[p]	1988[e]
MALI—Continued						
Stone: Marble		758	769	750	200	155
Gypsum[e]		300	300	300	[5]600	[r]720
Silver[e,17]	troy ounces	1,000	1,100	1,000	1,100	1,600
MAURITANIA[18]						
Cement		—	—	—	80,000	90,000
Gypsum		800	5,470	18,060	19,402	20,000
Iron and steel:						
Iron ore:						
Gross weight[19]	thousand metric tons	9,527	9,333	8,929	9,000	10,004
Iron content[e]	do.	5,754	5,600	5,840	5,850	6,500
Metal: Semimanufactures		898	4,481	5,512	5,465	5,500
Petroleum refinery products	thousand 42-gallon barrels	—	—	—	300	3,000
NIGER[4]						
Cement, hydraulic[e]		38,000	38,000	38,000	40,000	[r]26,400
Coal		123,644	150,635	123,644	164,000	160,000
Gypsum[e]		3,000	3,000	3,000	3,000	3,000
Molybdenum concentrate, Mo content[e]		33	20	20	8.3	15
Phosphate rock		[r]1,426	[r]200	—	—	—
Salt[e]		3,000	3,000	3,000	3,000	3,000
Tin, mine output, Sn content		76	134	80	94	[r]119
Uranium, U_3O_8 content of concentrate		[r]3,854	[r]3,807	[r]3,662	3,493	[r]3,482
SENEGAL[4]						
Cement, hydraulic		384,821	406,890	360,000	372,000	[r]390,956
Clays: Fuller's earth (attapulgite)		115,498	95,957	81,657	111,048	[r]108,425
Petroleum refinery products:						
Gasoline	thousand 42-gallon barrels	546	[e]540	550	800	[r]951
Jet fuel and kerosene	do.	401	[e]400	400	576	[r]799
Distillate fuel oil	do.	675	[e]680	650	1,270	[r]1,564
Residual fuel oil	do.	786	[e]790	750	1,395	[r]1,815
Other	do.	23	[e]20	20	43	44
Refinery fuel and losses	do.	233	[e]230	230	213	227
Total	**do.**	**2,664**	**[e]2,660**	**2,660**	**4,297**	**5,400**
Phosphate rock and related products:						
Crude:						
Aluminum phosphate	thousand metric tons	279	355	131	191	[r]119
Calcium phosphate	do.	1,932	1,814	1,850	1,874	[r]2,326
Manufactured:						
Aluminum phosphate, dehydrated	do.	142	200	60	89	[r]61
Other[20]	do.	7	8	5	4	[r]1.5
Salt[e]		165,000	160,000	145,000	100,000	75,000
SIERRA LEONE[12]						
Aluminum: Bauxite, gross weight	thousand metric tons	1,040	1,184	1,242	[r]1,390	1,379
Diamond:[21]						
Gem[e]	thousand carats	240	243	215	214	12
Industrial[e]	do.	105	106	100	100	6
Total	**do.**	**345**	**349**	**315**	**314**	**[r]18**

See footnotes at end of table.

TABLE 1—Continued

WEST AFRICA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

Country[1,2] and commodity[3]		1984	1985	1986	1987[p]	1988[e]
SIERRA LEONE—Continued						
Gold[21]	troy ounces	18,223	19,004	8,740	r13,578	629
Gypsum[e]		4,000	4,000	4,000	4,000	4,000
Iron ore		355,000	e70,000	—	—	—
Petroleum refinery products:						
Gasoline	thousand 42-gallon barrels	238	287	e300	250	200
Jet fuel	do.	128	162	e170	150	100
Kerosene	do.	93	55	e50	50	35
Distillate fuel oil	do.	709	443	e450	450	400
Residual fuel oil	do.	433	379	e360	360	325
Liquefied petroleum gas	do.	9	9	e9	9	8
Other	do.	1	1	e1	1	1
Refinery fuel and losses	do.	64	60	e60	60	50
Total	**do.**	**1,675**	**1,396**	**e1,400**	**1,330**	**1,119**
Salt[e,22]	thousand metric tons	200	200	200	200	200
Titanium:						
Rutile ore and concentrate 96% TiO_2, gross weight		91,300	80,611	97,100	r113,300	r126,000
Ilmenite ore and concentrate 60% TiO_2, gross weight		—	—	—	r5,600	r42,000
TOGO[4]						
Cement products:						
Clinker	thousand metric tons	154	—	—	—	—
Cement[23]	do.	243	284	348	370	r378
Iron and steel:						
Semimanufactures	do.	—	r7	r9	r12.1	14,000
Phosphate rock, beneficiated product	do.	2,400	2,450	r2,314	r2,644	r3,464
Stone: Marble, dimension	square meters	5,317	5,671	5,000	10,800	r27,000

[e] Estimated [p] Preliminary [r] Revised NA Not available

[1] Production data for Nigeria given in table 4.

[2] In addition to the countries listed, The Gambia and Guinea-Bissau, which are covered in the text of this chapter, presumably produced a variety of crude construction materials (clays, sand and gravel, and stone) but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

[3] In addition to the commodities listed, most of these countries produce clay, sand and gravel for local construction purposes. Information is inadequate to make reliable estimates of output levels.

[4] Includes data available through Dec. 15, 1989.

[5] Approximately 60% of estimated production is smuggled out of the country.

[6] Output based entirely on imported clinker.

[7] Reported figure.

[8] Does not include artisanal production smuggled out of country.

[9] Data are for fiscal year ending July 30 of that stated.

[10] Includes data available through Oct. 1, 1989.

[11] Includes estimated 400,000 carats of smuggled artisanal production.

[12] Includes data available through Aug. 1, 1989.

[13] Figure includes reported mine production of 10,300 troy ounces. Remainder represents approximate sales to Government of artisanal production.

[14] Includes data available through June 1, 1989.

[15] Data are based on gold taxes for export, and may include gold produced outside of Liberia.

[16] Includes estimates of artisanal production from, and smuggled into, Mali. Kalana Mine accounted for about 67% of total output in 1984 and 1985, 50% of output in 1986 and 1987, and about 20% in 1988.

[17] Estimated output from Kalana Mine only.

[18] Includes data available through Sept. 1, 1989.

[19] Reported iron ore exports.

[20] Products marketed under the trade names "Balifos" and "Phospal."

[21] Data are based on official exports and do not reflect smuggled material.

[22] Data do not include output of salt refined from annual imports of 4,000 to 10,000 tons of crude marine salt.

[23] Output based entirely on imported clinker except for part of 1984 production.

GHANA[8]

The Ghanaian economy grew more than 6% in 1988, the fifth successive year of expansion under an economic rehabilitation program backed by the International Monetary Fund (IMF) and the World Bank. Economic prosperity was, however, hindered by the fact that more than 70% of export earnings went to debt reservicing. In addition, low world prices greatly reduced earnings from cocoa, traditionally Ghana's major source of export revenues.

The Ghanaian minerals sector provided about 22% of Ghana's foreign exchange revenues, second only to cocoa. Gold was the dominant mineral produced, accounting for about 85% of mineral exports, and was the focus of most of the major expansion of mineral exploration in the country. In 1984, the Government initiated policies designed to reverse many years of decline in mineral production and of deterioration of equipment and infrastructure. As a result of the new policies and increases in some world commodity prices, particularly gold, the Government was able to attract foreign investment in the minerals industry.

Loans from the World Bank and other international financial institutions were being used to rehabilitate and expand the facilities at the Government-owned mines and at Ashanti Mines. Numerous foreign companies were actively engaged in exploration. The first new gold mine in several decades began operations in 1988 and others were expected to commence operations in 1989 or 1990. In a continuing effort to privatize the country's industries, the Government began soliciting bids for its three wholly owned gold mines. In addition, the Government took steps to legalize and encourage the country's artisanal gold and diamond mining in order to channel this significant existing production through legal channels, increase total gold and diamond production, and increase the general level of employment.

The World Bank granted the Government a $40 million interest-free loan to rehabilitate state-owned mines. The Government-owned State Gold Mining Corp. (SGMC) was to receive $36 million of this, with a stipulation that the Government was to privatize the properties. The United Nations Development Program (UNDP) assisted the SGMC in drawing up prospectuses for these mines. The loan to the SGMC represented about one-third the estimated total cost to rehabilitate the gold mines. Financing for the remainder was being sought from the African Development Bank, the European Investment Bank, and France's Caisse Centrale de Cooperation Economique. The remainder of the World Bank loan went to Ghana Consolidated Diamonds Ltd. (GCD) and to Ghana National Manganese Corp. (GNMC).

Production and Trade

Ghanaian export earnings in 1988 increased about 5% to more than $868 million.[9] As in previous years, the export economy was dominated by sales of cocoa and cocoa products. Although cocoa sales volume was up slightly, sales revenues decreased by almost $100 million to about $400 million as a result of depressed world cocoa prices. Timber exports earned about $106 million.

Total mineral exports were about $193 million. Gold exports accounted for $164 million of this, which represented about 19% of Ghana's total exports and a 10.3% increase over 1987 sales. Gold production actually increased almost 14%, but world gold prices were slightly lower in 1988. Bauxite production increased about 30%, and aluminum production increased by almost 8%. Cement production increased dramatically. Production of manganese ore fell significantly, largely as a result of depletion of high grade oxide reserves. While table 1 shows a production increase for diamonds in 1988, this reflects the inclusion, for 1988 only, of the estimated artisanal production smuggled out of Ghana. Production from the country's only diamond mine fell almost 50% as the result of the continuing deterioration of equipment and a general lack of spare parts.

Commodity Review

***Metals.*—Aluminum.**—As in years past, all of Ghana's bauxite production came from the Ghana Bauxite Co. (GBC) mine at Awaso. GBC was a joint venture between the Government (55%) and British Alcan Aluminium Ltd. (45%). The mine was producing well under capacity because of an inadequate railroad infrastructure to the exporting port of Takoradi. Ghana also has bauxite reserves at Kibi, and the Government had a long-term goal of using this bauxite to supply the Volta Aluminum Co. (VALCO) smelter at Tema. The main constraint was the cost of constructing the necessary infrastructure. The Soviet Union submitted a feasibility study on this project in 1988, but its conclusions had not been announced at yearend.

In recent years, aluminum production by VALCO had dropped because of decreased hydroelectric power supplies resulting from low water levels in Lake Volta. Continued low water levels as late as July 1987 led to fears about low production levels again in 1988, but heavy rains later in the year led to rapid water accumulation in the reservoir. As a result, VALCO restarted 40% of its fifth potline in early 1988, thus raising its aluminum production capacity by 10% at yearend to 176,000 tons per year. Production increased 8%, but fell short of capacity because of both the gradual nature of the potline restart and shortages of alumina.

Gold.—Ghana's recorded gold production of 372,979 troy ounces was its highest since 1978 and was an almost 14% increase above 1987 production. The increase was due to the opening of

a new gold mine and to significant progress made in the rehabilitation and expansion programs at the existing gold mines. There were several advanced exploration projects ongoing at yearend; it was anticipated that some of these would become mines within the next few years. These favorable developments were results of the liberalized legal and financial conditions set forth in the 1986 Minerals and Mining Law. It was predicted that the country's gold production would reach 1 million troy ounces per year by the mid-1990's.

Gold smuggling remained a problem. The Government proposed setting up eight district centers in an attempt to regulate the activities of the small-scale mining sector. These centers were to be located at Akim Oda, Assin Fosu, Bibiani, Dunkwa, Enchi, Kibi, Konongo, and Tarkwa—all areas known to have much illegal small-scale mining. The Government hoped that by regulating small scale miners, revenues perhaps as high as $100 million annually would be forthcoming. The district offices would issue licenses, provide safety and technical training, and provide an official channel through which gold could be legally sold. The Government proposed granting the small-scale miners a tax holiday to encourage them to sell their gold through these new legal channels. Gold (and diamond) sales were to be to licensed Ghanaian buyers at prices fixed weekly. The official buying price was expected to be about 93% of the world price.

By far the largest gold producer was Ashanti Goldfields (Ghana) Corp. (AGC), a joint venture between the Government (55%) and Lonrho Plc (United Kingdom), which operated the Ashanti Mine at Obuasi. Gold production in 1988 increased 11.5% to 311,767 troy ounces, which was almost 84% of the country's total production. Gold sales increased 8.2% to $136.8 million, which represented about 16.5% of Ghana's total export revenues.

The expansion and rehabilitation program, begun in 1984, for the Ashanti Mine complex, continued. This $156 million program, partly financed by the International Finance Corp. (IFC)-World Bank ($45 million) and a European bank consortium ($26 million), had the goal of raising the Ashanti Mine's gold output to 400,000 ounces per year by 1990. The new 2,600-foot George Cappendell shaft was commissioned during the year and it was planned to effectively double its depth by sinking a winze. Work continued on the 5,200 foot Kwesi Mensah shaft, which was expected to be completed by 1991 for a cost of $27 million. An air-recirculation calcining furnace was added to the plant facilities, which was faster and cheaper to operate than its predecessor. To meet increased production goals, financing was being sought for a new processing plant to come on-line in 1995. In addition, AGC began reclaiming, using a newly commissioned $8 million plant, about 20 million tons of tailings at a rate of 2,000 tons per day (to be doubled by 1990). Encouraged by the recent application of heap-leach technology at the new Southern Cross Mine, AGC mined some surface portions of its ore body. Gold production capacity at known grades was 420,000 ounces per year, up from 320,000 ounces per year in 1987. The company expected to produce 348,000 ounces of gold in 1989, of which 36,000 ounces was to be from heap-leach recovery from surface workings.

AGC began a program to reactivate surface and underground mines and prospects at Sansu, 16 kilometers south of Obuasi. The total cost of this project was not announced, but the company was securing a $25 million loan from the World Bank for this. The remainder of the costs were to be borne by the company. The production plant for this site was expected to be completed in 1989 at a cost of $16 million. Mining was expected to commence in the last quarter of 1989 at a rate of 100,000 tons per month of low-grade, heap-leachable surface ores.

Total combined production from the Government-owned SGMC increased 4% to 50,295 troy ounces; sales were almost $22.5 million. SGMC produced gold from two underground mines (Prestea and Tarkwa) and from one dredging operation (Dunkwa). At yearend, SGMC had virtually completed negotiations for a loan for the second phase of its ongoing mine rehabilitation program. The $112 million loan was to be from the World Bank ($35 million), European Investment Bank ($18 million), African Development Bank ($35 million), Caisse Centrale of France ($10 million), and private and commercial loans ($14 million). As a result of the rehabilitation program, total SGMC production was expected to increase to more than 120,000 ounces per year by the early 1990's.

The Prestea Mine produced 23,471 ounces of gold from 214,000 tons of ore. This was an almost 20% increase in ore milled and was an indication of early benefits from the rehabilitation program. However, the gold production was only about 5% higher owing to lower ore grades and the fact that graphite in the ore adversely affected gold recovery in the mill. Tarkwa's production increased almost 10% to 20,053 ounces. The production from Dunkwa, however, fell almost 15% to 6,771 ounces, in contrast to the 61% production increase experienced in 1987. This decrease was largely due to the need for repair to several of the company's dredges.

As part of its ongoing efforts to privatize the Ghanaian economy, the Government began soliciting bids for the three SGMC operations toward yearend.

In May, Southern Cross Mining (SCM) opened a mine at Obenemase near Konongo. This was the first new gold mine to be opened in Ghana in more than 40 years. SCM was a joint venture between North Queensland Co. of Australia (70%) and SGMC. The joint-venture agreement was for a period of 30 years and covered a 126-square-

kilometer concession. Production in 1988 was 10,853 ounces, which was one-third of the expected full-production output. There was a possibility that output would be expanded to 100,000 ounces per year in 1990. The mine was developed at relatively modest cost and was an open pit, heap-leach operation, mining oxide ore from Birimian metavolcanics and metasediments as well as processing old tailings. The company was not yet mining its sulfide ore reserves, which, it was recognized, would require more expensive processing. The mine's oxide and sulfide reserves were reported to be almost 1.9 million tons grading 5.85 grams (0.19 ounce) of gold per ton. Reported tailings reserves in the immediate area were about 1.8 million tons grading 0.97 grams (0.03 ounce) of gold per ton. The company had identified an additional 287,000 tons of oxide and sulfide ore reserves, grading 11.76 grams (0.38 ounce) of gold per ton, near the old SGMC Konongo Mine. Exploration was continuing and at yearend more than 4,000 samples of various types remained to be assayed. It was anticipated that the reserves would be increased once the results of these analyses became available.

As in 1987, there was a great deal of exploration for gold in Ghana during the year. Most projects involved either lode deposits in the Birimian and Tarwaian systems in the southwestern portion of the country, or placer deposits believed derived from these systems.

One of the most advanced exploration projects was that of Canadian Bogosu Resources Ltd. (CER) on the Bogosu concession. Marlu Gold Mining Areas Ltd. produced 924,000 ounces of gold from 7.5 million short tons of ore from this area between 1936 and 1955. CBR started as a joint venture of Sikaman Gold Resources Ltd. of Canada (40.5%), Denison Mines of Canada (27%), Denison-affiliate Exall Resources Ltd. (13.5%), the Ghanaian Government (10%), and the IFC (9%). In early 1988, Billiton BV (Netherlands) purchased the 40.5% share held by Denison-Exall. Minproc Engineering (Australia) was the project engineer. Debt financing of the project was by the World Bank at an estimated capital cost of $45 million. The concession was believed to contain minable reserves of both oxide and sulfide ore as well as about 6 million tons of old dumps.

The ongoing project involved drill-testing 5 of at least 14 targets on a mineralized zone some 18 kilometers long. The exploration program involved about 40,300 feet of diamond core drilling (155 holes). Proven and probable open pit geological reserves based on this $9 million exploration and feasibility study program were reported to be about 924,000 ounces of gold within about 8 million short tons of ore. More than 65% of these reserves were considered as proven. Minable reserves were estimated at 6.5 million short tons grading 0.12 ounce of gold per ton. A treatment plant with an initial capacity of 825,000 short tons per year and a startup production rate in excess of 100,000 ounces per year was recommended. It was hoped to eventually increase that rate. Production costs were calculated to be $147 per ounce for the first 3 years and $181 per ounce for the life of the project. Total capital costs for the project were estimated to be $67.6 million, including 1989 preproduction costs, working capital, and interest during construction. The remaining targets were considered to have a potential for 3 to 5 million short tons of open pit reserves grading 0.12 ounce of gold per ton and more than 10 million short tons of underground reserves grading 0.12 to 0.30 ounce of gold per ton. Old dumps and tailings on the concession were reported to amount to 6.6 million tons containing 174,000 ounces of gold in proven reserves. Production was anticipated to start late in 1989.

Another advanced project was that of Teberebie Goldfields Ltd., which was a joint venture of Pioneer Group Inc. of the United States (63%), Glencar Explorations (United Kingdom) PLC (27%), and the Government (10%). The Teberebie project is 5 miles southwest of Tarkwa, in Tarkwaian conglomerate banket ores similar to those at the SGMC mine. Exploration in 1987, including detailed sampling of trenches and adits, delineated reserves of about 10 million tons grading 1.85 grams (0.06 ounce) per ton. A similar quantity of possible reserves were outlined immediately north of the original target. Diamond drilling continued in 1988. By yearend, proven reserves were about 6 million tons grading about 2 grams (0.064 ounce) per ton, and possible reserves of about 11 million tons at a similar grade had been identified along strike. A 30-year mining lease was signed with the Government in February. The project had some delays late in the year in finalizing equipment supply contracts, but open pit mining was expected to commence in late 1989 or early 1990. Total capital costs to bring the project into production had been estimated at about $27.5 million, but the project delays were expected to increase these costs. Gold production costs were estimated to be about $162 per ounce. Mining was to be at a rate of 4,600 tons per day, with an expected 75% gold recovery of about 60,000 ounces per year by heap leaching once full production is reached by mid-1990. However, the company was considering adding another work shift to increase eventual production to 100,000 ounces per year. In October, Teberebie Goldfields secured a $9 million loan from the Overseas Private Investment Corp. (United States) toward development of the mine.

Cluff Taywood Mining Co. (Cluff), a joint venture between Cluff (50%) and Taylor Woodrow Plc (50%) (both of the United Kingdom), was awarded licenses to explore various historic gold mines and prospects for minable targets similar to those operated by Cluff in Zimbabwe. At the Mpesetia property near Kumasi, 2,400 meters of trenching and resampling of surface workings and old adits confirmed the presence of

several parallel gold-bearing shears. A 250-meter-long zone of continuous oxide mineralization was identified on one of these shears. It averaged 10 meters in width at a grade in excess of 6 grams (0.19 ounce) of gold per ton. Three nearby, but separate, zones were identified. They had similar strike lengths, widths of 20 to 60 meters, and grades averaging 1 to 3 grams (0.03 to 0.1 ounce) of gold per ton. Other prospects held by the company were at Bokitsi near Dunkwa, near Affo, and near Miradani.

Ghana-Australian Goldfields Ltd. (GAG), a joint venture between Golden Shamrock Mines of Australia (90%) and the Government (10%), was studying plans to develop a surface gold mine on its Iduapriem property 10 kilometers southwest of Tarkwa. The area has supported small mining operations for over a century. Trench sampling identified a resource of about 9 million tons grading 2.9 grams (0.09 ounce) of gold per ton. The ore was in conglomerate (banket) reefs over a strike length of 9 kilometers. Drilling commenced in May with encouraging results. Development costs were estimated to be $25 million, largely because the low grades would require a high degree of mechanized mining. It was estimated that the project could support a 1-million-ton-per-year operation producing between 85,000 and 110,000 ounces per year over a mine life of 8 to 10 years. Gold production costs were estimated to be $250 per ounce. A production decision was expected in March 1989.

Europa Minerals Ltd. (United Kingdom) was exploring for alluvial gold and diamonds as well as heavy minerals in beach sands at the mouth of the Pra River. The company had a large financial stake and management responsibility in the Dana Exploration Plc (Ireland) alluvial gold property on the Offin River. Bulk sampling and reconnaissance drilling there confirmed the continuity of two placer deposits—a high terrace area containing an estimated 80,000 cubic meters grading 0.4 gram (0.013 ounce) of gold per cubic meter and a low terrace area containing 1.32 million cubic meters grading 0.58 gram (0.019 ounce) of gold per cubic meter. These deposits were open. Reserves sufficient for a 2-year mining operation were delineated in the high terrace gravels where the overburden was thin. Pending approval by the Government, it was anticipated that mining could commence in late 1989. Work by Selection Trust in the 1930's suggested that the Offin River channel contained dredgeable reserves of 170,000 ounces of gold, and Europa Minerals Ltd. was considering diverting the river to gain access to these gravels when mining extended to the low terrace gravels.

The United Nations (U.N.) Revolving Fund for Natural Resources (UNRFNRE) reported that field operations had begun on a gold project on a 1.4-square-kilometer area near Prestea, between the SGMC lease and that held by CBR. The work was to include mapping, geophysical and geochemical surveys, and followup trenching and drilling as justified. Known reserves were more than 3 million tons grading 5 grams (0.16 ounce) of gold per ton. UNRFNRE was cosponsoring the project with the Agency for International Technical and Economic Cooperation (Sweden).

BHP-Utah International Inc. (Australia) commenced a reconnaissance exploration program over a large area south of Prestea and west of Tarkwa.

Manganese.—Ghana's manganese production continued to decline because of diminishing reserves of oxide ore and by problems at the loading facilities at Takoradi. Earlier problems with the railroad from the Nsuta Mine to the port had been partly alleviated. Extensive efforts to increase oxide reserves have reportedly led to delineation of about 5 million tons; however, it was still felt that the mine would exhaust its high-grade reserves in about 5 years. There were extensive reserves, perhaps 20 million tons, of carbonate ore. A calcining furnace built during the period 1979–82 remained uncommissioned at yearend. It was expected that the kiln would remain unused because the mine was able to sell all of the carbonate ore it produced to the Japanese and expected to continue to be able to do so.

GNMC entered into an agreement with Geomin (Romania) to explore the manganese reserves on the GNMC concession. Ghana received an offer from Bulgaria, Czechoslovakia, and Romania to purchase manganese ore.

***Industrial Minerals.*—Cement.**– Ghana's cement production increased 74% to 477,000 tons. This increase was due to the increased availability of foreign exchange, which allowed an increase in clinker imports.

Diamonds.—Ghana's official diamond production, which does not include estimates of smuggled production, was 244,881 carats in 1988; a significant decrease from 1987 and the third consecutive year of decline. However, newly available information has allowed the inclusion in table 1 of an estimate of smuggled artisanal production for 1988. The Akwatia Mine, operated by GCD, accounted for 225,200 carats of the total production, a 48% decline from the previous year. This decline was largely due to the continuing deterioration of equipment and a lack of spare parts.

In 1987, the focus of mining at Akwatia was shifted from the old high terrace gravel deposits, now largely exhausted, to channel gravels on the Birim River. The reserves in this area were delineated by the U.N. and could support an annual production of 1 million carats for at least 15 years. Equipment problems prevented the mine from approaching these output levels. In addition, the long ore haulage to the old plant contributed to the high cost of the operations.

As in previous years, smuggling of diamonds was a problem. The Government estimated that this smuggled production amounted to 450,000 to

600,000 carats annually, worth at least $10 million. In an effort to check smuggling in the Akwatia area, it was announced that GCD was now paying attractive rates for diamonds produced by artisanal miners.

In a further effort to reduce smuggling and to encourage the legitimate production of diamonds by small-scale miners, the Government announced that it would allocate mined-out areas of the GCD concessions to private companies. New equipment was commissioned at two small-scale mining companies, Cayco (Ghana) Ltd. and Ntboase Mining Co., in the West Akim District.

Mineral Fuels.—**Petroleum.**—It was announced in March that Libya had agreed to resume supplying crude oil to Ghana on favorable payment terms and to reschedule, without interest, the remaining debt for oil supplied to Ghana in 1983.

Amoco (Ghana) Production Co. signed an exploration agreement in 1987 for the offshore Ada concession. This 2,200-square-kilometer concession extended from the Accra area to the Togolese border. The company was committed to drilling one exploration hole by August; however, no results had been announced as of yearend.

Petro-Canada International Assistance Corp. (PCIAC) continued with its petroleum exploration assistance program begun in 1983. In 1988, PCIAC agreed to provide up to $8.1 million in goods and services to help the Ghana National Petroleum Corp. earn an interest in an undisclosed offshore block that was to be acquired by a consortium led by Atlantic Richfield Co. The Netherlands Government agreed to finance the cost of a drill ship for a multiwell program.

GUINEA [10]

Mining continued to be crucial to the Guinean economy, accounting in 1988 for about 22% of the country's gross domestic product (GDP) and 95% of its export revenues. Sales of bauxite and alumina accounted for only about 74% of Guinea's export revenues, compared with a traditional export reliance of more than 90%. This was due to diversification of the mining sector and the general economy in recent years, and not to a decrease in production of these commodities. The Government continued to encourage exploration and development of other mineral resources so as to broaden the country's mineral export base. Special attention was given to the development of gold and diamond production. At yearend, Guinea had one operating gold mine, one diamond mine, and a second diamond deposit in the advanced stages of exploration. There was also significant but undocumented production by artisanal miners of gold and diamonds, much of which was reportedly smuggled out of the country. In order to capture some of the foreign exchange earnings from undocumented gold sales, the Government in 1987 authorized commercial banks to purchase gold on its behalf from sellers who could remain anonymous. Up to one-half of the purchase price could be paid in hard currency. Purchases of gold were facilitated by the opening of commercial bank branch offices throughout the country. The Government reported purchasing more than a ton of gold in this manner in 1988.

An accord was reached during a visit by Guinean officials to Morocco for the two countries to form a joint company to prospect for gold, diamonds, and other minerals in Guinea's Mandiana Province. Morocco would finance the exploration, which would be capitalized or reimbursed upon the discovery and exploitation of minerals. The agreement also provided for the training of Guineans in Morocco in the sectors of geology, mines, and energy. Morocco was already involved in a uranium exploration consortium in Guinea.

A possible mineral exploration joint venture with the Government of Guinea-Bissau was discussed during the late November visit to Conakry by the Guinea-Bissau President. The joint venture's purpose would be the exploration and mining of bauxite in Gaoual Prefecture in Guinea and in the Madinaboué area of Guinea-Bissau and the joint exploitation of possible petroleum reserves along the common border.

Although it was announced in July that Yugoslavia would build an oil refinery in Guinea as a symbol of cooperation between the two countries, no date was given for the start of construction.

During a March visit to Guinea by the Romanian President, it was announced that there would be intensified cooperation between the two countries in several fields, including mining. A commitment was made for Romania to purchase 1 to 2 million tons of iron ore per year from the Mount Nimba deposit once it achieved production. However, no agreement resolving the iron ore project's myriad development problems had been reached at yearend, and production of iron ore in the near future was considered unlikely.

Production and Trade

Guinea remained the second largest producer of bauxite in the world. Production increased almost 16% to just under 17 million tons. Alumina production increased slightly. Bauxite exports increased about 17%; however, sales revenues fell about 10% to about $352 million as a result of a decrease in the world bauxite price.

Recorded production of diamonds fell 16%. This decrease was mitigated by higher world prices for gem diamonds and the continued production of a very high percentage of high-quality stones, including one large stone of extraordinary quality that sold for a world-record price. Recorded gold production increased, both as a result of the startup of a new placer mine, and the legal sale of at least a portion of the gold produced by artisanal miners.

Guinea imported all of its refined petroleum products needs, amounting to approximately 2.6 million barrels. Of this, about 1.25 million barrels was fuel oil. Imports of petroleum products from the U.S. consisted of about 8,000 barrels of lubricants and a small amount of asphalt.

Commodity Review

***Metals.*—Bauxite and Alumina.**—Guinea's bauxite production increased by 15.5%, largely owing to an increase in production to about 11 million tons at the Sangáredi Mine of Compagnie des Bauxites de Guinée (CBG). Metallurgical-grade bauxite production was slightly more than 16 million tons and production of calcinated bauxite was about 264,000 tons. Production of alumina increased by 6% to 590,000 tons.

In February, an agreement was signed with the Central Fund for Economic Cooperation (France) whereby France granted a loan of 90 million francs ($15 million) for the financial reorganization of Friguia consortium, led by Pechiney (France), which mines bauxite for conversion to alumina for export. Later in the year, the European Community Mining Aid program (SYSMIN) approved a loan of 35 million European currency units (ECU) ($38.5 million) to Friguia, and it was announced that the European Investment Bank had plans to provide an additional 13 million ECU. The loans were to be used to upgrade Friguia's alumina plant, its bauxite mine, and road and port facilities. Emphasis was on reducing the alumina plant's energy consumption. These improvements were expected to restore alumina production capacity to 600,000 tons per year initially and to 670,000 tons per year by 1993. Production costs were expected to decrease almost 14% to about $114 per ton.

At yearend, the Guinean Government was studying the possibility of building an alumina plant for CBG, but recognized that this would require a large hydroelectric project. The feasibility of an aluminum smelter was also under study. Negotiations were underway with the Soviet Union for financial and technical assistance for these projects.

Gold.—Guinea's official gold production was 10,288 troy ounces. This did not include unrecorded artisanal production, estimated in the past to be about 60,000 ounces per year, most of which reportedly had been smuggled out of the country. Because of new purchasing arrangements started in 1987, some of the artisanal production began to be sold through legal channels. In 1988, these sales amounted to about 1 ton (approximately 32,000 ounces).

Almost all of the official gold production came from the Koron placer mine in the 23,000 square-kilometer Siguiri Concession. The mine was owned and operated by Société Aurifère de Guinée (SAG), which was a joint venture between the Government (49%) and Chevaning Mining and Exploration Co. (CMC) of the United States (51%). Union Minière S.A. (Belgium) acquired a 50.1% stake in CMC in 1987, with the remainder owned by Omnium Natural Resources (United Kingdom)—itself a subsidiary of Swiss merchant bank Société Financière Omnium (SFO). In May, Pancontinental Mining Ltd. (Australia) purchased the 25.45% SFO stake in SAG.

The initial mining plan for Koron was based on proven reserves of 9.2 million cubic meters of auriferous gravel grading 2 grams (0.06 ounce) of gold per cubic meter. Plant construction took place over a 12-month period. The engineering work was originally done by Wright Engineers (Canada), but this firm was replaced by Mechim, an engineering subsidiary of Union Minière, following the latter's acquisition of a majority interest in CMC in 1987. The pay zone gravels at Koron are confined to a narrow channel about 12 kilometers long, and the processing plant was moved periodically along this channel to avoid lengthy ore haulage. Plant processing capacity was designed to produce approximately 60,000 troy ounces of gold annually, but it was anticipated that this output could be increased to 90,000 ounces per year. Trial operations were underway early in 1988 and the first bullion was poured in July. It was expected that 875,000 cubic meters of gravel would be mined the first year to yield 55,000 ounces of gold; however, startup problems limited production to about 10,000 ounces. Revised estimates of future production were 45,000 ounces for 1989 and 60,000 ounces for 1990. Exploration was ongoing to increase the reserves. In addition, SAG was looking into the possibility of using a metal detector to recover nuggets larger than 1.25 inches, the maximum recoverable size for the existing processing plant. SAG had a second deposit, unmined in 1988, at Didi, with reserves of 3.5 million cubic meters of gravel grading 1.3 grams (0.04 ounce) of gold per cubic meter.

A gold-recovery circuit was added in 1987 at the Aredor diamond mine, but did not progress beyond the pilot stage because of low and irregular gold grades. Gold recovery in 1988 was only about 160 ounces.

France's BRGM and Kenor A.S. (Norway) were continuing their exploration and mine feasibility studies of the Matagania gold placer at Dinguiraye near Siguiri and of the old gold workings at Banora.

Iron Ore.—No agreement had been reached at yearend in the ongoing negotiations between the Liberian-American-Swedish Minerals Co. (LAMCO) in Liberia and various partners in the Société Minière de Fer de Guinée (Mifergui) consortium concerning the start of mining operations at the iron ore deposit at Mount Nimba near the Liberian border. The project hinged on the ability to connect the deposit by 17 kilometers of

track to the railroad infrastructure in Liberia associated with LAMCO's iron mine at Yekepa. There were many problems associated with the project. The LAMCO infrastructure was deteriorating, and as the LAMCO mine was scheduled to close at yearend 1989, the timing of the startup of mining at Mount Nimba was crucial in terms of rail and port maintenance. LAMCO desired a role beyond merely leasing the infrastructure. There was concern on all sides that the original 12-member Mifergui consortium was unwieldy. It was felt that a new Mifergui, consisting of LAMCO plus three members (BRGM and the Governments of Guinea and Liberia) from the old Mifergui, was more workable, but difficult questions remained concerning the legal and financial concerns of the other partners in the original Mifergui. The Governments of Romania and Nigeria were committed to purchasing significant quantities of the ore, and one French partner in Mifergui expressed interest in both purchasing iron ore and helping with the project's financing. Nevertheless, overall agreement and financing remained very much in doubt at yearend, and announced forecasts of project startup in 1990–91 were considered optimistic.

***Industrial Minerals.*—Diamonds.**—Diamonds were produced by one mine as well as by artisanal miners; all operations involved alluvial deposits. A separate exploration effort, that of Star Diamond Co. (United Kingdom), was ongoing at yearend, but was reported to be plagued by logistical problems.

As in 1987, all official diamond production in Guinea was from the Aredor Mine at Gbenko. Part of its 1988 production was from relatively low-grade zones on the boundaries of richer areas mined in 1987 and of those being prepared for mining in 1989. The mining of low-grade ore, together with some maintenance problems experienced toward yearend, resulted in a 16% decline in diamond yield to 146,439 carats. Aredor diamonds were sold for an average of $315 per carat, excluding very large stones. This 10.5% price increase greatly mitigated a sales volume decrease of almost 76% to about 118,600 carats. Diamond production averaged 93% gem quality, with an average stone size of 0.82 carat. Past production had included several large diamonds of extraordinary quality. In 1988, a 181.77 carat stone was found, which sold in November for almost $8.62 million. This price of more than $47,000 per carat was believed to be the highest ever paid for a rough diamond.

Exploration at Aredor during the year increased proven and probable reserves to 897,280 carats, which represented 5 to 6 years of production. Negotiations with the Government were ongoing at yearend to extend the Aredor lease to cover about 400 square kilometers of prospective ground adjacent to the existing concession.

GUINEA-BISSAU[11]

Production of mineral commodities in 1988 was limited to an undocumented quantity of building materials for local consumption. Towards yearend, the Governments of Guinea-Bissau and Guinea met in Conakry, Guinea, to discuss joint exploration for bauxite in the Madinaboué area of Guinea-Bissau, and in Gaoual Prefecture in Guinea. Joint exploration for petroleum was also discussed.

LIBERIA[12]

The Liberian economy was mixed in 1988, with the private sector showing strength, but with Government expenditures continuing to exceed revenues. The private sector export economy grew in response to higher world prices for iron ore, rubber, and hardwood lumber.

Liberian Government expenditures continued to exceed revenues, with financing of commitments being achieved through the increase of debt and the further issuance of newly minted Liberian coin. By yearend, the foreign debt had reached $1.7 billion, which was more than double the debt in 1981. The Government deficit was about $25 million at yearend, at which time Liberia's loans were some $670 million in arrears. In response to the lack of Governmental fiscal control, major donors such as the IMF, World Bank, and the African Development Bank continued to suspend disbursements to Liberia. For much the same reason, the United States continued to reduce aid to the country.

In late 1987, in an effort to restore U.S. foreign aid to Liberia, the Liberian President invited the United States Government to send a team of experts to manage the Liberian economy. This team arrived in January 1988, but left at yearend, having failed to in its efforts to convey the importance of fiscal restraint. One positive outcome, however, was Liberia's repayment during the year of $15 million in loans to the United States. This repayment was essential under U.S. law for continued U.S. assistance to Liberia.

In March, it was announced that a contract had been signed with a West German firm to assume total responsibility for operating, maintaining, and developing the port of Monrovia for a 3-year period. It was hoped that this would stimulate international trade by improving port services, security, and cargo handling capacity.

The Liberian private sector showed strength and resiliency during the year. In 1988, export levels for iron, rubber, and hardwood lumber increased in response to higher world prices for these commodities. Increased cutting of trees to meet export demands for lumber, with the attendant proliferation of small slash-and-burn farms, led to environmental questions concerning the destruction of the Liberian rain forest. Rubber and lumber were expected to assume an increasingly important role in the export economy, as iron ore

TABLE 2

LIBERIA: IRON ORE EXPORTS[1]

(Metric tons)

Destination	Product[2]	1984	1985	1986	1987	1988
			LAMCO Joint Venture			
Austria	wf	—	—	—	88,000	—
Belgium	wf	405,000	689,000	662,000	931,000	1,251,140
	wl	830,000	542,000	665,000	—	153,500
France	wf	795,000	761,000	441,000	759,000	689,030
	wl	185,000	336,000	183,000	142,000	155,110
	hg	—	—	—	255,000	—
German Democratic Republic	wf	—	—	—	—	36,750
	wl	68,000	72,000	—	37,000	—
Germany, Federal Republic of	wf	1,834,000	1,590,000	1,658,000	458,000	641,480
Italy	wf	1,077,000	937,000	852,000	828,000	1,000,290
	wf	—	—	—	—	12,290
Japan	c	312,000	173,000	305,000	72,000	297,860
Netherlands	wf	163,000	—	—	68,000	—
Nigeria	wl	335,000	297,000	—	116,000	153,980
Pakistan	wf	159,000	265,000	309,000	179,000	—
Poland	hg	62,000	—	—	—	—
Romania	wf	377,000	51,000	—	—	1,128,950
	wl	—	—	—	497,000	—
Spain	wl	394,000	554,000	719,000	785,000	660,430
	wf	—	—	—	28,000	15,000
Turkey	wf	250,000	128,000	32,000	—	—
United Kingdom	wf	—	—	—	60,000	—
United States	wf	1,636,000	2,067,000	1,738,000	896,000	128,000
Yugoslavia	wf	—	67,000	—	—	191,590
	hg	163,000	—	—	—	—
Total		**9,045,000**	**8,529,000**	**7,564,000**	**6,191,000**	**6,515,540**
			Bong Mining Co.			
Germany, Federal Republic of	sf	2,648,877	2,871,111	2,864,966	2,733,994	2,839,000
	pt	1,855,568	2,129,086	1,466,331	2,174,296	2,169,000
Italy	sf	1,169,622	1,488,150	1,359,240	1,350,423	1,146,000
	pt	960,707	1,087,909	1,232,890	1,052,859	1,033,000
Total		**6,634,774**	**7,576,256**	**6,923,427**	**7,311,572**	**7,187,000**

[1] Data do not include production from National Iron Ore Co. (NIOC) mine, which closed in 1985.

[2] wf = washed fines, wl = washed lumpy, hg = high-grade fines, c = concentrates, sf = sinter feed, pt = pellets.

exports, traditionally accounting for about 50% of export revenues, were expected to decrease after the 1989 scheduled closure of the LAMCO Joint Venture (LJV) mine.

Production levels for mineral commodities were mixed, with increases reported for cement and gold production, but decreases reported for diamonds and iron ore.

Trade

Liberia's iron ore exports in 1988 increased by 1.4% to 13.7 million tons. The major buyers of Liberian iron ore, as in previous years, were European countries: the Federal Republic of Germany (41%), Italy (23%), Belgium (10%), and Romania (8%). In contrast, the United States purchased only about 1% of Liberia's production. Table 2 provides a breakdown by product type and purchasers of Liberia's iron ore exports for 1984 through 1988.

Commodity Review

Diamonds and Gold.—Reported production for diamonds fell by about one-third to 167,030 carats, of which, it was estimated, 40% were of gem quality. In contrast, reported gold production increased by about 45% to 21,753 troy ounces. Much of Liberia's gold and diamond production was by artisanal miners, and official records were not considered to be a reliable estimate of total production because of smuggling of both Liberian and neighboring countries' production through Liberia. Estimates of the value of this unreported trade in gold and diamonds ran as high as $240 million. In an attempt to reduce the smuggling of gold, the Government announced in May that the National Bank, rather than the previously licensed dealers, would handle all gold purchases. No mechanism to implement this had been set up by yearend.

Western Mining Corp. (Australia) was negotiating for land and financial concessions pertaining to a planned major exploration program for gold and diamonds. This program had strong support from the Liberian President, as it was seen as having major potential to help the Liberian economy at a time when projected iron ore revenues would be decreasing. A sticking point in the negotiations was the Liberian requirement that exporters surrender 25% of their foreign exchange earnings to the Government in exchange for Liberian dollars at the official rate, instead of the parallel exchange market rate.

Iron Ore.—The iron ore sector has been for the last quarter century the largest single factor in the Liberian economy, in recent years accounting for nearly 25% of the country's GDP and about one-half of the country's exports. In 1988, iron ore was produced by LJV and Bong Mining Co. (BMC). Negotiations were continuing with the Government of Guinea concerning the MIFERGUI-Nimba iron ore project; however, no agreement had been announced as of yearend. This $130 million project would connect the Guinean iron deposit at Mount Nimba with the LJV infrastructure by means of 17 kilometers of new track and would have the advantage to Liberia of keeping the LJV infrastructure in operation long after the LJV mine had exhausted its ore.

The most significant development in the iron ore sector was the announcement that the scheduled date for closure of the LJV mine at Yekepa had been advanced from mid-1990 to yearend 1989. The LJV explanation for this change was that the high-grade ore at Yekepa had been depleted more rapidly than expected. It was agreed that company benefits would continue to be paid to the workers in line with the original, mid-1990 closure announcement.

In contrast, BMC embarked on an expansion program that would allow mining of the ore in the Bong Peak area of its mining concession. Production from this area was predicted to keep BMC mining in Liberia until 2006. Because of the recent improvement in world iron ore prices, BMC finances improved after many years of losses. BMC conducted a program in 1988 to test the effect of semi-autogenous grinding on power consumption in the grinding cycle. It was recognized that the harder ores expected to be mined by 1995 would require an 85% increase in power consumption using the existing autogenous grinding cycle. The tests showed that semi-autogenous grinding would result in only a 17% power increase. As it was also found that an acceptable, if coarser, product could be had with the current softer ores using semi-autogenous grinding, it was decided to convert the existing grinding cycles to this mode. But the coarser product required more secondary and tertiary grinding, which negated about one-third of the power savings. Further tests were planned. Tests were also conducted in 1988 on removing alkali-bearing minerals from the harder ore mill feed.

Total Liberian iron ore production fell by 7.1% to 12.8 million tons. Production by LJV fell 14% to about 5.7 million tons. The BMC production fell only 0.5% to about 7.1 million tons. Recent production for the two companies is summarized in table 3. Figure 1 shows the workforce distribution between the mines for recent years.

Steel.—An $8 million secondary steel and gas production complex, having a capacity of 2,000 steel rods per day, began production in 1988. The complex is owned by a consortium of

TABLE 3

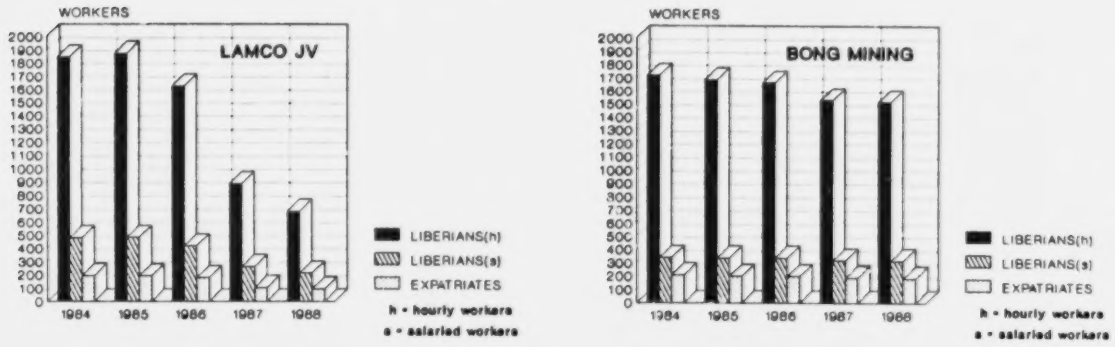
LIBERIA: IRON ORE MINE PRODUCTION

(Metric tons)

Product	1984	1985	1986	1987	1988
			LAMCO Joint Venture		
Concentrate	517,000	411,000	549,000	550,000	47,249
Washed lumpy	1,027,000	1,027,000	779,000	230,000	280,468
Washed fines	5,652,000	6,332,000	827,000	5,815,000	5,338,117
Total	**7,448,000**	**7,770,000**	**8,155,000**	**6,595,000**	**5,665,834**
			Bong Mining Co.		
Sinter feed	3,294,820	4,294,820	4,178,215	4,110,693	3,918,334
Pellets	2,994,617	3,032,840	2,961,775	3,036,671	3,182,751
Total	**6,994,617**	**7,327,660**	**7,139,990**	**7,147,364**	**7,101,085**

FIGURE 1

EMPLOYMENT TRENDS IN THE LIBERIAN IRON ORE INDUSTRY



three Liberian companies: Atlantic Oxygen Corp., which makes industrial gasses; Atlantic Steel Works Inc., which makes rods; and Atlantic Shipbreaking Inc., which uses scrap to make steel rods. The complex employs 100 Liberians and 10 expatriates.

MALI[13]

The production of gold continued to dominate the mining industry of Mali; gold export revenues in 1988 were about $37 million and made up about one-fifth of the country's total exports.[14] Gold was produced by one underground mine, and by numerous artisanal miners. Reported gold production increased significantly, but likely included gold smuggled in from neighboring countries. Some Malians worked as artisanal gold miners on a seasonal basis in Burkina Faso. The mining industry was otherwise characterized by the production of small quantities of cement, gypsum, marble, and salt.

There was significant gold exploration ongoing during the year, especially in the Kéniéba region, and, most notably, at Syama in the Bagoé region. At the latter, one company completed feasibility studies that were expected to lead to a favorable production decision in early 1989. Toward yearend, the French Government signed an agreement worth $2.65 million to help with gold exploration programs in the Kéniéba and Kangaba areas.

In August, the Soviet Union granted a $6.7 million commercial loan to rehabilitate the Socima cement factory at Diamou. Earlier in the year, a new company was formed to further exploit reserves of marble near Kayes.

Commodity Review

***Metals.*—Gold.**—Mali's 1988 gold production was listed as about 85,200 troy ounces. About 16,000 ounces of this was from the Kalana Mine, the only official mine in operation. The remainder was from artisanal production in Mali and, probably, artisanal production smuggled into the country from Burkina Faso and Guinea.

The Kalana Mine continued to be the only large-scale operation in the country. The state-owned underground mine was run by the Société de Gestion et d'Exploitation des Mines d'Or de Kalana (SOGEMORK), with Soviet technical assistance. Gold production in 1988 increased almost 50% to about 16,000 troy ounces. The ore graded about 0.33 troy ounce per ton and had a gold-to-silver ratio ranging from 7 to 10. The gold is primarily within low-angle quartz veins penetrating both a pipe-like dioritic stock and the Birrimian-series country rocks. Some gold is also found associated with arsenopyrite and pyrite in the country rocks adjacent to the stock. Both the mine and the mill were undergoing expansion to provide for an increase in gold production to about 32,000 ounces per year starting in 1990. Mining was hampered by a high rate of water infiltration into the workings. A further problem was the high cost of diesel fuel needed for the mine's generators. The Soviet Union was financing the construction of powerlines to link the mine with the hydroelectric plant at the Sélingué Dam.

BHP-Utah International Inc. of Australia (BHP) continued exploration work on the Syama concession granted to it by the Government in mid-1987. The company had been attracted to the area based upon findings of a regional exploration program, conducted by the United Nations Development Program, which located a significant gold anomaly near 13th- to 15th-century gold

workings. Work, begun by BHP in May 1987 and continued during 1988, consisted of detailed pitting and auger and diamond drilling of the Syama deposit, as well as reconnaissance mapping and sampling of other areas along the trend. Gold was found free and associated with iron sulfides in quartz veinlets and in their altered host rocks. The host rocks are steeply-dipping Birrimian-series basalts, tuffs, and fine-grained clastics. Oxide ore reserves included tailings and backfill from ancient gold workings. Sulfide ore was encountered at 35- to 40-meter depth and was drill-tested to a depth of 90 meters.

At yearend, reserves minable by open pit at the Syama deposit were reported to be 2.1 million tons grading 3.7 grams (0.12 ounce) of gold per ton of oxide ore (proven), and 2.5 million tons grading 5.5 grams (0.18 ounce) of gold per ton of mixed and sulfide ore (proven and probable). Preliminary mining feasibility studies were based on open pit mining of only the oxide ore. A production decision was expected to be made by early February 1989. The company was planning a drilling program for 1989 to prove underground minable sulfide reserves. At yearend 1988, indicated underground sulfide reserves were 4.5 million tons grading 7.2 grams (0.23 ounce) of gold per ton.

In April, Sikaman Gold Resources Ltd. of Canada announced that it had acquired from Victory Exploration Corp. Inc. of Canada an option to earn a 99% equity interest in a 517-square-kilometer gold concession in the Kéniéba area. Sikaman was involved in this effort on an earn-in, joint-venture basis with Billiton BV of the Netherlands (49.5%), Canadian Magnesite Mines Ltd. (10%), and Equatorial Gold Mines NV of the Netherlands (9.5%). Billiton was to be the project's operator and manager. A soil and rock sampling program over two target areas was carried out from May to September, but the assays showed erratic values and poor repeatability because of nugget effects. A rotary-percussion drilling program, totaling 1,500 meters, was conducted from July to December; the results were being evaluated at yearend. Additional drilling was planned for 1989.

In October, the Société Minière de Loulo (Somilo) was formed to exploit the Loulo deposit north of Kéniéba. The company was a joint venture between the BRGM-Coframines (49%) and the Government (51%). The decision to proceed with mining followed a 1987 feasibility study by Syndicat de Recherche de l'Or, a BRGM subsidiary, which showed recoverable gold reserves of about 225,000 troy ounces. Production was anticipated for the end of 1989, at an initial rate of about 12,800 ounces per year.

In July, Canadian Mali Gold Corp. signed an agreement with the Government to dredge alluvial gold on the Niger River in the Kangaba region.

***Industrial Minerals.*—Marble.**—Mali-Marbre was formed to exploit a marble deposit at Sélinkégni in the Kayes region. The company was a joint venture between Institut Nationale Belge des Industries Extractives of Belgium and Torrence Ltd. of the United Kingdom (combined 51%), the Société Nationale de Recherche et d'Exploitation des Ressources Minières du Mali (20%), and miscellaneous Malian nationals (29%). Production of 5,000 tons per year of high quality marble was expected to commence in 1990.

MAURITANIA[15]

The depressed iron ore markets of the early 1980's and the recurrence of severe droughts adversely affected Mauritania's narrow resource-based economy. External debt service obligations substantially exceeded payment feasibility. To compensate, the Government adopted a comprehensive Economic and Financial Recovery Program for the 1985–88 period. The objectives were to create a foundation for sustained growth and to restore the balance of payments to a viable position. The program included a flexible exchange rate policy, a restrictive monetary and credit policy to curb the inflation rate, the rehabilitation of the public sector, investment priorities for productive sectors (fisheries and mining), and an incentive framework to promote private investment. These measures sustained promising results while the GDP annual growth rate was about 1.5% to 3.6% during the 1985–88 period compared with 0.8% in the 1981–84 period. The inflation rate was reduced to 6.3% in 1988 compared with 13.6% in 1985. The number of public servants was frozen, and public investment was cut from 22.7% of the GDP in 1985 to 13.9% in 1988 by limiting the program to economically justified, high-priority projects. Public and private investment programs focused on fisheries, iron ore mining, intensified hydrocarbon exploration, and infrastructure development for more effective use of existing assets.

The new economic plan covering the period 1989–91 projected a growth rate of 3.5% annually by essentially continuing the program started in 1985, which revitalized the economy.

To encourage exploration and development, a new petroleum code was adopted on November 11, 1988, updating and consolidating existing legislation. Included in the code was a guarantee that foreign companies holding a contract for hydrocarbon exploration and production may repatriate capital, dividends, and interests without the imposition of taxes on transferred funds.

Production and Trade

Iron ore continued to be Mauritania's principal mineral commodity with production and exports reported at 10 million tons valued at $144 million[16]. Mining commenced in 1963, and for two decades was by far the leading foreign exchange earner. More recently,

sales of fish and fish products have become the nation's leading foreign exchange earner, with iron ore and small quantities of gypsum and plaster products accounting for about one-third of all export earnings. Mauritania enjoys a number of advantages over most iron ore exporters, including the proximity of the western European markets and the capacity of its port to accommodate larger ships of 120,000 to 150,000 deadweight tons. These limit the cost of ore transport to Europe to $3.00 per ton.

Petroleum products refined from Algerian crude oil piped to the Nouadhibou refinery were sufficient to meet most domestic requirements. Mauritania's expenditures on fuel and energy imports in 1988 were reported at $25 million reduced from $33 million in 1987 before refinery operations restarted.

Commodity Review

***Metals.*—Copper.**—Production at the Akjoujt Mine was scheduled for resumption by late 1989. The mine had been closed since 1978 due to technical problems and an uncertain investment climate driven by a prolonged period of low copper prices. Total investment for the reactivation was estimated at $40 million. The mine will be operated by the Société Arabe Minière D'Inchiri (Samin). The Mauritanian Government owns a 37.4% interest in the company; Jordan, 32.5%; Iraq, 12.5%; Libya, 10.1%; and the Arab Investment Co., 7.5%.

Mining operations will focus on the sulfide ore body remaining below the oxide ores extracted in earlier operations. Mine reserves were estimated at 100 million tons of ore averaging 2.25% copper and 1.17 grams of gold per ton. Initial output was anticipated at 65,000 tons annually of a 25% copper concentrate.

Gold.—Recovery of gold from 2.5 million tons of copper tailings from earlier mining operations at the Akjoujt Mine was scheduled to begin in 1989. The tailings contained 3 to 5 grams of gold per ton (0.08 to 0.15 troy ounce per short ton). When fully operational, gold extraction from old tailings as well as from new mining operations at the Akjoujt Mine should reach 1,000 kilograms annually.

Iron Ore.—Mining was conducted by the Société Nationale Industrielle et Minière-Société d'Economie Mixte (SNIM) in the Kedia d'Idjill deposit where additional reserves of 65% iron (Fe) content ores have been identified, which will permit extraction at current levels to continue through the mid-1990's. Earlier estimates called for reserve depletion by 1990, after which time all mine activity would shift to the lower iron content magnetite ores of the desert plains known as the Guelbs.

Phase 1 of the Guelbs project included the El Rhein open pit mine, which was inaugurated in mid-1984 with reserves estimated at 285 million tons of 37% Fe content ore. At full capacity, mine output was planned at 13.8 million tons per year using conventional mining methods employing 15-meter benches and a maximum 50° slope.

The ore beneficiation plant employed a dry enrichment process involving magnetic separation. Planned output for the plant was 6 million tons per year of a concentrate averaging 65% Fe content in the form of 1.2 million tons of magnetite sinter-plant feed, 2.6 million tons of oxidized sinter feed, and 2.2 million tons of fine-grained magnetite concentrate. The beneficiation plant operated well below capacity largely due to the rapid wear of the mills and a dust buildup. Output was estimated at 2 million tons.

In 1988, the African Development Bank, the Arab Fund for Economic and Social Development, Caisse Centrale de Coopération Economique, the European Development Bank, and the Kuwait Fund for Arab Economic Development financed a $70 million loan to solve beneficiation problems at the El Rhein plant and to improve rail line and port facilities. Plant modifications included replacement of materials to improve resistance to abrasion, installation alterations to improve material flow, and redesign to facilitate plant maintenance.

The second mine in the Guelbs project, Oumm Arwagen, originally was scheduled for operation in 1990 from a reserve base of 100 million tons. However, development was delayed by the identification of additional higher grade reserves at Kedia d'Idjill, the necessity of improving concentrating operations at El Rhein, and improving world iron ore market conditions. By 1988, the plan for phase 2 of the Guelb development project shifted away from the Oumm Arwagen deposit in favor of developing the Mhaoudat deposit about 30 kilometers to the northeast. It has proven reserves of 100 million tons of ore containing 64% to 68% iron, 0.003% phosphorus, 0.001% sulfur, 2% to 7% silica, and 0.57% alumina. SNIM reported that development cost was estimated between $70 and $100 million.

***Industrial Minerals.*—Gypsum.**—Production was derived from the N'Drahamcha quarry, 50 kilometers northeast of Nouakchott. The quarry was owned and operated by the Société Arabe des Industries Metallurgiques Maritano-Koweitiennes. Although annual capacity was reported at 120,000 tons, actual output dictated by the market demand was estimated at 20,000 tons.

Phosphate.—Discovered and evaluated by SNIM, BRGM (France), Geomin (Romania), and Compagnie Sénégalaise des Phosphates de Thiès, the Bofal deposit in southern Mauritania was estimated to contain 120 to 150 million tons of phosphate-bearing material averaging 20% P_2O_5. The remote location of the deposit required high infrastructure costs and financing was not yet secured.

Mineral Fuels.—**Petroleum.**—Exploration.—Exploration activities were conducted by Texaco and Amoco in the southern and central coastal waters. Following the completion of seismic surveys and geological analyses under a 1984 exploration agreement, Texaco prepared to drill an exploratory well in early 1989 in Block 8. By a second agreement signed in July, Texaco added the adjoining onshore Block 9 north of Rosso to its exploration concession. Amoco completed its investigation for hydrocarbon seepages as required by the terms of its exploration and production-sharing agreement signed in late 1987. A seismic survey was planned by Amoco in early 1989.

Refining.—Mauritania's sole refinery was owned by the Société Mauritanienne d'Industrie de Raffinage (SOMIR). The 20,000-barrel-per-day-capacity refinery, at Nouadhibou, was designed to process Algerian crude oil, and was closed from 1983–87 due to financial and technical difficulties. After completion of a $30 million renovation program funded by Algeria, and the signing of an agreement by the Mauritanian Government to purchase at world prices products that met domestic consumption requirements, the refinery reopened in September 1987 under the technical management of Naftal, an Algerian oil corporation. In 1988, the refinery operated at 57% capacity with a throughput averaging 11,400 barrels per day (bbl/d) of Algerian crude oil.

NIGER[17]

Niger's economy in 1988 was dominated by the minerals industry, notably uranium mining. Niger was the seventh largest producer of uranium in the world and reportedly had the fifth largest uranium reserves. Sales of uranium concentrate amounted to $255 million[18] and accounted for 69% of the country's total export revenues and almost 11% of the GDP. Niger also exported small quantities of molybdenum concentrate and tin (as cassiterite), and produced coal and salt for consumption by the uranium mining industry.

Uranium concentrate was produced by two companies, Société des Mines de l'Aïr (SOMAÏR) and Compagnie Minière d'Akouta (COMINAK), both of which operated mines near Arlit in the northern part of the country. Both companies were joint ventures between the Government and various French, Spanish, German, and Japanese firms. France's Compagnie Générale des Matières Nucléaires (COGEMA) was the dominant partner, holding 27% of SOMAÏR and 34% of COMINAK.

Reported total uranium production was essentially unchanged from that in 1987 and was about two-thirds of total rated capacity. Uranium sales were by long-term contracts to the joint venture partners. It was believed, however, that actual sales exceeded reported sales by a considerable amount. COGEMA was the major purchaser of uranium concentrate, reportedly at well in excess of world uranium prices. The Government was attempting to find additional markets for the country's uranium production in order to be able to increase the production at the existing mines and to develop additional deposits discovered during the 1970's. This effort was hindered by low world demand for uranium and the country's high uranium production costs, which were about double the world price for the commodity.

In late 1987, because of increased mining costs with increasing depth at the open pit mine at Arlit, SOMAÏR shifted part of its efforts to a new deposit 4 kilometers to the southwest. The new Tassa N'Taghalgué (TAZA) deposit was reported to have proven reserves of 21,000 tons of uranium metal. SOMAÏR suffered a miners' strike at Arlit at about the same time as the TAZA mine was opened, but, reportedly, the strike did not last beyond early 1988.

Electricity for the uranium mines was generated by a steam plant burning low-grade coal mined by Société Nigérienne de Charbon d'Anou Araren. Both the coal mine and the powerplant were operating well below capacity, as both had been designed to service uranium mines, planned in the 1970's, but never developed. Salt for the COMINAK uranium processing plant was produced by Société des Salines de Tidekelt, which became operational in 1988 under joint Government and Belgian management.

Niger had artisanal production of gold, largely from workings in the Tera sub prefecture near the Burkina Faso border. Production data were unavailable. Canadian-funded studies were underway in 1988 on the feasibility of larger scale exploitation of several of the deposits in this region. In 1987, a 6-month trial placer operation in this area, sponsored by the BRGM, reportedly recovered about 30 kilograms (960 troy ounces) of gold.

NIGERIA[19]

Although receipts from Nigeria's principal foreign exchange earner, petroleum, declined by nearly 10% to $6.4 billion,[20] the economy grew 4.1% largely because of the growth in agricultural output, in manufacturing, and in construction. The structural adjustment program launched in mid-1986 continued past its June 1988 closing date because the Government experienced a measure of success in restructuring the economy by diversification and reducing dependence on petroleum exports for foreign exchange earnings. Some aspects of the structural adjustment program included abolition of export controls, elimination of factory price controls, retention of all foreign exchange earnings by nonoil exporters, and reduction in petroleum product subsidies for individual but not commercial consumers. Since the program

has been in effect, the nation's economic growth has reversed from a negative 2.1% in 1986 to a positive 1.0% the following year and was projected to continue a 4% growth in 1989.

Major problems included a $29 billion debt, high import requirements for many raw materials and finished products, and continued weak international oil prices. Petroleum accounted for 13% of real GDP, but represented 77% of all federally collectible revenues. Crude oil and products accounted for 89% of total export earnings, reduced from the 1986 level of 94%. In an attempt to partially offset weak crude oil prices that dropped from $16 to $12 per barrel, Nigeria's crude oil production exceeded the Organization of Petroleum Exporting Countries (OPEC) allotted quota of 1.355 million bbl/d.

In November, the Government launched a debt-conversion program reducing external debt and increasing direct investment in Nigeria.

By December, Nigeria commenced drawing on a $500 million balance-of-payment loan made available from the World Bank.

Major mineral developments during the year focused on conserving foreign exchange through import substitution. These included commissioning of the Onne Fertilizer Complex and construction of petrochemical facilities for carbon black and linear alkyl benzene production. Other developments included firming up markets for the export of liquefied natural gas and construction of pipelines for transport of associated gas to powerplants.

In December, an 11-member National Energy Commission was inaugurated with a mandate to evolve a comprehensive energy policy for the country.

Production and Trade

Production of crude oil, Nigeria's principal mineral commodity, averaged 1.45 million bbl/d in 1988. More than 80% of the crude oil or 1.2 million bbl/d were exported. More than one-half was destined for the United States and the remainder for Europe. Natural gas produced in association with petroleum averaged 1.8 billion cubic feet per day, most of which was flared. Production of low-grade iron ore commenced, but most remained in stockpile until required by the Ajaokuta Steel Complex. The ammonia and urea production units of the Onne Fertilizer Complex were completed prior to the construction of the mixed fertilizer unit. This provided Nigeria with exportable quantities of ammonia at an opportune time when ammonia exports from Persian Gulf nations were curtailed due to the Iran-Iraq war.

Commodity Review

***Metals.*—Gold.**—The Nigerian Mining Corp. was the financial backer of the newly formed Nigerian Gold Mining Co. Ltd., producing gold concentrates at Ilesha, Oyo State. Mineral excavation in 1988 was planned at 78,000 cubic meters, but less than one-third of the plan was realized. Resulting gold production was reported as 38 troy ounces (about 1.2 kilograms) from 21,168 cubic meters of gravel.

Drilling and other sampling activities continued at the Iperinda Reef, confirming a reserve reported as 383,000 tons of ore containing about 128,000 troy ounces (about 4,000 kilograms) of gold in the 1-kilometer-long lode.

Iron and Steel.—Production of low-grade run-of-mine iron ore from the Itakpe Hill Mine was reported at 304,300 tons in 1988, an increase of 64,000 tons. Production was being stockpiled pending construction of a beneficiation plant, the Osara Dam power source, and the railroad line linking Itakpe to the Ajaokuta Steel Complex.

Civil engineering work on the Ajaokuta Steel Complex was halted in late 1987 when French construction contractors Dumey and Fougeralle sought to collect $190 million. By yearend 1988, the Nigerian Government agreed to make oil revenues available to service the debt, and construction was scheduled to resume in early 1989. The commissioning of the first phase of the integrated steelworks consisting of four rolling mills, an oxygen blast furnace, and ancillary facilities was projected for 1992. Only the powerplant, rolling mills, and general servicing units were operational in 1988. They used imported billets and blooms as feedstock for an output of 5,437 tons of steel products. The mill design capacity includes 100,000 tons of wire, 145,000 tons of bar, 275,000 tons of light structural products, and 560,000 tons of medium structural products.

Commissioned in 1982, the Delta Steel integrated steel plant, based on Midrex direct reduction of iron ore and electric arc steelmaking, operated at an estimated 20% of capacity. This was because the shortage of foreign exchange hampered the purchase of imported iron ore, ferroalloys, and other raw materials. Reported production included 58,200 tons of rolled products and 133,000 tons of billets.

In addition to the integrated steel plants, the Government owned three inland rolling mills each with capacities of 210,000 tons per year of wire and bar products. The mills were commissioned by the Nigerian Government as part of its industrial dispersion program. In addition, 17 privately owned rolling mills provided the country with an excess of capacity for wire products in contrast to a surge in demand for flat sheets and plates.

Tin.—The now totally Government-owned Makeri Smelting Co. was Nigeria's sole tin producer. In preparation for adapting to electric arc tin smelting, the company was upgrading the electricity supply of the smelter.

Tin production was considerably less than the 1,000-ton Nigerian quota allocated by the Association of Tin Producing Countries for 1988. Nigeria has mined most of the easily accessible cassiterite. Unless further investments in

TABLE 4

NIGERIA: PRODUCTION OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity		1984	1985	1986	1987[p]	1988[p]
METALS						
Columbium and tantalum concentrates, gross weight:						
Columbite		126	101	13	48	50
Tantalite		1	1	—	—	—
Iron and Steel:						
Iron ore, gross weight	thousand tons	—	—	—	240	304
Steel, crude	do.	187	254	200	184	192
Lead:						
Mine output, Pb content[e]		200	260	100	86	85
Metal, refined secondary		600	800	1,000	300	500
Tin:						
Mine output, cassiterite concentrate:						
Gross weight		1,808	1,500	630	844	432
Sn content		1,340	1,100	460	603	300
Metal, smelter		1,400	1,079	91	560	566
Zinc ore and concentrate, Zn content		(2)	1,000	(2)	(2)	(2)
INDUSTRIAL MINERALS						
Cement, hydraulic	thousand tons	3,600	3,600	3,860	[r]3,800	3,400
Clays:						
Kaolin		286	300	169	177	105
Unspecified		20,000	20,000	15,000	15,000	15,000
Feldspar[e]		—	5,000	3,500	[3]485	190
Nitrogen:						
N content of Ammonia	thousand tons	—	—	—	225	300
N content of Urea	do.	—	—	—	200	260
Stone:						
Limestone	do.	1,890	1,800	1,850	2,627	1,712
Marble		1,200	1,200	1,482	6,900	5,445
Shale	thousand tons	127	120	104	88	86
MINERAL FUELS AND RELATED MATERIALS						
Coal	do.	76	140	144	110	150
Gas, natural:						
Gross	million cubic feet	583,000	618,000	642,000	643,000	660,700
Marketed	do.	97,000	108,000	116,000	117,000	120,000
Petroleum:						
Crude	thousand 42-gallon barrels	508,000	544,252	534,165	486,869	569,400
Refinery products:						
Gasoline	do.	22,000	23,000	18,600	19,000	21,000
Jet fuel	do.	400	400	400	490	500
Kerosene	do.	6,400	10,200	8,700	9,000	10,600
Distillate fuel oil	do.	14,547	17,500	12,400	12,500	15,000
Residual fuel oil	do.	9,990	11,300	15,330	14,000	13,600
Unspecified	do.	1,563	3,650	4,700	5,000	5,000
Total	**do.**	**54,900**	**66,050**	**60,130**	**59,990**	**65,700**

[e] Estimated. [p] Preliminary.
[1] Includes data available through June 15, 1989.
[2] Less than 1/2 unit.
[3] Reported figure.

TABLE 5

NIGERIA: EXPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity		1987	Destinations, 1987	
			United States	Other (principal)
METALS				
Aluminum:				
Ore and concentrate		627	—	Ghana 600; Ivory Coast 17.
Metal including alloys, semimanufactures		48	—	Mali 46.
Columbium and tantalum: Ore and concentrate		126	—	All to Netherlands.
Copper:				
Ore and concentrate		80	—	All to China.
Metal including alloys, semimanufactures	kilograms	200	—	All to Gabon.
Iron and steel:				
Iron ore and concentrate, unspecified		2,436	—	United Kingdom 2,032; Spain 404.
Metal:				
Scrap		4,792	—	Spain 2,934; West Germany 887.
Steel, primary forms		119	—	Ghana 113.
Semimanufactures:				
Bars, rods, angles, shapes, sections		2,287	—	Ghana 479; Spain 142; United Kingdom 119.
Universals, plates, sheets		485	—	All to Italy.
Tubes, pipes, fittings		2,433	—	Netherlands 2,432.
Tin:				
Ore and concentrate		155	—	All to Netherlands.
Metal including alloys:				
Unwrought		250	—	Do.
Semimanufactures		100	—	All to West Germany.
Zinc: Ore and concentrate		1,250	—	West Germany 1,000; United Kingdom 250.
Other: Ores and concentrates		2,208	—	West Germany 1,741; Netherlands 298.
INDUSTRIAL MINERALS				
Fertilizer materials: Manufactured:				
Ammonia		74,807	—	Hong Kong 16,000; Tunisia 16,000; Bermuda 8,007.
Nitrogenous		90,719	12,939	Bermuda 37,778; West Germany 31,002.
Salt and brine		2	2	
Sodium compounds, n.e.s.: Sulfate, manufactured		44	—	All to Benin.
MINERAL FUELS AND RELATED MATERIALS				
Asphalt and bitumen, natural		179	—	All to Liberia.
Petroleum:				
Crude	thousand 42-gallon barrels	479,109	257,407	Netherlands 42,474; Canada 32,528.
Refinery products:				
Liquefied petroleum gas	value, thousands	$84	—	Benin $47; Niger $21.
Gasoline:				
Aviation	thousand 42-gallon barrels	4	—	All to Chad.
Motor	do.	1,427	—	Chad 833; Niger 589.
Kerosene and jet fuel	do.	2	—	Chad 1; Niger 1.
Distillate fuel oil	do.	1,484	3	Niger 1,305; Chad 73.
Residual fuel oil	do.	731	58	Ivory Coast 160; Greece 122.
Asphalt	do.	1,226	—	Benin 1,187.

[1] Data not available for 1986. Table prepared by Virginia A. Woodson.

TABLE 6

NIGERIA: IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity	1987	Sources, 1987	
		United States	Other (principal)
METALS			
Aluminum: Metal including alloys:			
Unwrought	11,306	72	United Kingdom 9,898; Spain 983.
Semimanufactures	6,500	146	Italy 1,491; West Germany 1,324; United Kingdom 1,140.
Copper: Metal including alloys:			
Unwrought	112	—	West Germany 85; Spain 26.
Semimanufactures	4,661	27	West Germany 2,279; United Kingdom 1,101.
Iron and steel:			
Iron ore and concentrate, unspecified	6,104	—	Romania 2,610; Liberia 1,900; West Germany 1,175.
Metal:			
Scrap	38	—	Italy 32; Ireland 4.
Pig iron, cast iron, related materials	9,008	37	Japan 5,603; China 1,965.
Ferroalloys:			
Ferromanganese	2,515	—	West Germany 1,481; Hong Kong 1,003.
Unspecified	457	—	Brazil 281; West Germany 176.
Steel, primary forms	175,402	28,397	France 45,721; Spain 32,544.
Semimanufactures:			
Bars, rods, angles, shapes, sections	97,830	653	West Germany 26,443; France 23,087; Italy 16,114.
Universals, plates, sheets	2,407,539	2,468	Japan 784,261; United Kingdom 272,659; West Germany 149,882.
Hoop and strip	20,451	2	China 7,253; United Kingdom 3,509; West Germany 2,977.
Rails and accessories	650	126	West Germany 470; United Kingdom 49.
Wire	56,127	44	West Germany 34,688; Brazil 8,072.
Tubes, pipes, fittings	636,870	60,817	Italy 126,967; France 115,834; West Germany 113,981.
Castings and forgings, rough	12,060	17	Italy 4,533; Belgium-Luxembourg 2,556; West Germany 1,705.
Lead: Metal including alloys:			
Unwrought	1,283	—	Belgium-Luxembourg 974; West Germany 260.
Semimanufactures	534	(e)	Belgium-Luxembourg 233; West Germany 183.
Nickel: Metal including alloys:			
Unwrought	13	—	All from Netherlands.
Semimanufactures	117	—	United Kingdom 35.
Tin: Metal including alloys:			
Unwrought	62	48	France 14.
Semimanufactures	2,766	1	Japan 1,346; France 687; Netherlands 248.

See footnotes at end of table

TABLE 6—Continued

NIGERIA: IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity	1987	Sources, 1987	
		United States	Other (principal)
METALS—Continued			
Uranium and thorium: Metals including alloys, all forms kilograms	7,811	—	West Germany 5,119; Belgium-Luxembourg 2,692.
Zinc: Metal including alloys:			
Unwrought	1,875	—	Belgium-Luxembourg 1,193; West Germany 366.
Semimanufactures	1,900	(2)	United Kingdom 1,305; Belgium-Luxembourg 394.
Other: Ores and concentrates	3,323	—	Netherlands 2,067; Romania 862.
INDUSTRIAL MINERALS			
Abrasives, n.e.s.: Natural: Corundum, emery, pumice, etc.	4,094	652	West Germany 1,935; Iceland 793.
Asbestos, crude	38,156	100	Canada 14,496; Brazil 9,990; Morocco 5,552.
Fertilizer materials:			
Crude, n.e.s.	178,768	—	Romania 83,756; Yugoslavia 46,121; Hungary 28,485.
Manufactured:			
Ammonia	2,486	9	France 1,862; West Germany 194.
Nitrogenous	779,292	20,503	Yugoslavia 539,162; Romania 178,523.
Phosphatic	234,583	—	Romania 217,581; Israel 14,000.
Potassic	1,519	—	Spain 564; United Kingdom 531; China 424.
Unspecified and mixed	13,522	422	Singapore 9,393; China 1,882.
Pigments, mineral: Iron oxides and hydroxides, processed	6,056	597	United Kingdom 2,603; West Germany 1,087.
Salt and brine	453,959	104	United Kingdom 90,324; Poland 74,791; Italy 70,121.
Sodium compounds, n.e.s.:			
Carbonate, manufactured	1,354	70	Italy 274; Poland 250; Romania 200.
Sulfate, manufactured	25,297	6,158	United Kingdom 5,399; West Germany 4,328.
Stone, sand and gravel	92,261	574	Spain 39,391; Greece 18,288; Italy 14,912.
Sulfur: Elemental, crude including native and byproduct	4,174	652	West Germany 1,935; Iceland 793.
MINERAL FUELS AND RELATED MATERIALS			
Asphalt and bitumen, natural	55,659	596	Morocco 16,216; United Kingdom 12,440; Turkey 7,085.
Coal: Anthracite and bituminous	1,357	21	U.S.S.R. 1,115.
Coke and semicoke	1,617	—	Taiwan 560; West Germany 397; United Kingdom 380.
Peat including briquets and litter	875	—	Denmark 840.
Petroleum refinery products:			
Liquefied petroleum gas value, thousands	$732	$296	United Kingdom $170; Italy $145.

See footnotes at end of table.

TABLE 6—Continued

NIGERIA: IMPORTS OF MINERAL COMMODITIES[1]

(Metric tons unless otherwise specified)

Commodity		1987	Sources, 1987	
			United States	Other (principal)
MINERAL FUELS AND RELATED MATERIALS—Continued				
Petroleum refinery products—Continued				
Gasoline:				
Aviation	42-gallon barrels	26,923	17,133	NA
Motor	do.	434,070	96	West Germany 285,235; United Kingdom 23,707.
Mineral jelly and wax	value, thousands	$6,329	$191	United Kingdom $2,493; West Germany $1,848.
Kerosene and jet fuel	42-gallon barrels	34,573	9,161	Belgium 25,335.
Distillate fuel oil	do.	3,112,678	22	West Germany 3,112,006.
Lubricants	do.	41,183	4,955	United Kingdom 16,390; West Germany 9,935.
Residual fuel oil	do.	23,290	853	France 11,661; Belgium-Luxembourg 4,502.
Asphalt	do.	20,180	4,842	United Kingdom 9,205; West Germany 2,527.

NA Not available.
[1]Data not available for 1986. Table prepared by Virginia A. Woodson.
[2]Less than 1/2 unit.

equipment and training are realized, production can only gradually decrease.

***Industrial Minerals.*—Fertilizer and Fertilizer Materials.**—The National Fertilizer Co. of Nigeria commissioned the Onne Fertilizer Complex in February. The complex consisted of three plants: a 1,000-ton-per-day ammonia plant; an associated urea plant with a capacity of 1,500 tons per day; and a 1,000-ton-per-day nitrogen-phosphorus-potash (NPK) fertilizer plant. The latter was capable of producing various grades of fertilizers designed to accommodate Nigerian crop and soil conditions. Built by a five-company consortium led by M.W. Kellogg, the complex is expected to provide 70% of Nigeria's NPK fertilizer consumption requirements and 100% of its granular urea demand. This could save $100 million annually in foreign exchange. Natural gas feedstock for the complex was supplied via an 8.7-mile-long pipeline connecting the Alakiri Field with the complex.

The abundance of natural gas available as feedstock prompted a feasibility study by Scientific Design Co. (United Kingdom) for a second fertilizer complex at Onne. Phosphate rock deposits in Ogun State and potash deposits in Bono State were under investigation as possible substitutes for imported phosphoric acid and potash.

***Mineral Fuels.*—Coal.**—The Nigeria Coal Corp. allocated over $200 million for development and expansion programs, including expansion of the Enugu underground mines in Anambra State as well as the expansion of the Okaba and Owukpa surface mines and the development of a new deposit at Ogbouoga in Benue State. The Nigerian Coal Corp. reported that the objective of the programs was to increase output to 3 million tons annually by 1991, of which two-thirds would be exported. About 300,000 tons would be utilized at the Ajaokuta Steel Mill for blending with imported coking coal and 700,000 tons would be used by the Nigerian Electric Power Authority.

Petroleum.—Exploration and Development.—The nationally owned Nigerian Producing Development Corp. was created in March by the Nigerian Government. The corporation was charged with developing crude oil and natural gas production in concessions owned solely by the Nigerian National Petroleum Corp. It was also responsible for exploration in the more remote inland areas of Nigeria, where equity partners are not active.

Shell Petroleum Development Co., Société Nationale Elf Aquitaine, AGIP Energy and Natural Resources, Texaco Inc., Nigerian Producing Development Corp., and Mobil Producing Nigeria Ltd. fielded a total of 9 to 12 seismic

TABLE 7

NIGERIA: IRON AND STEEL PLANTS IN 1988

(Million metric tons per year)

Plant	Description	Capacity		Remarks
		Liquid steel	Rolled products	
Delta Steel, Warri	Four 100-ton electric arc furnaces	1.00	0.32	Integrated Plant. Government owned. Includes Midrex DRI lines.
Ajaokuta Steel, Ajaokuta	Rolling mills	—	1.10	Dependent on imported billets at present. Government owned.
Integrated Ajaokuta Steel Plant (Expected completion 1992)	One blast furnace	1.30	—	Feed to be local iron ore and either imported coking coal or a blend with local coking coal, probably from Lafia. Government owned.
Jos Steel, Jos	Rolling mills	—	.21	Government owned.
Katsina Steel, Katsina	do.	—	.21	Dependent on Delta Steel for 120-millimeter-square billets. Government owned.
Oshogbo Steel, Oshogobo	do.	—	.21	Government owned.
Qua Steel, Eket	do.	—	.10	Cross Rivers State Govt. in partnership with Danieli of Italy. Dependent on imported billets.
Universal Steel, Lagos	One 8-ton and one 10-ton electric arc furnace.	1.05	.08	Furnace operated on scrap. Rolling mill augmented with imported billets.
CISCO Ltd., Ikeja	One 20-ton electric arc furnace	.06	.15	do.
Selsabeed Metals, Lagos	Rolling mills	—	.10	Dependent on imported billets.
Allied Steel, Onitsha	do.	—	NA	Plant mostly idle.
General Steel Mills, Asaba	One 8-ton electric arc furnace	.02	.05	Very little activity. Dependent upon imported billets.
Nigerian Spanish, Kano	One 20-ton electric arc furnace	.08	.20	Very active plant. Recently invested in water-cooled panels and continuous casting machine, and built a new rolling mill.
Mayor Engineering, Lagos	Rolling mills	—	.01	Recently invested in new rolling mill.
Metcome (Nig.) Ltd., Owerri	do.	—	.03	Operational.
Kew Metals Lagos	One 5-ton fuel fired furnace	.01	.02	do.
Kwara Commercial, Ilorin	Rolling mills	—	.04	do.
Niger Steel, Emene	One 7-ton electric arc furnace	.02	.02	Plant idle.
Asiatic Mandarin	Rolling mills	—	.06	Operational.
Federal Steel Mills, Otta	One 12-ton electric arc furnace	.05	.14	do.
Alliance Steel Co. Ltd., Ibadan	Rolling mills	—	.02	do.
Ore Steel, Oro, Ilorin	do.	—	NA	Commissioned in 1985.
Union Steel, Ilorin	do.	—	NA	do.

NA Not available.

parties in each month of 1988. Most of the activity was focused in the Niger River Delta and its immediate offshore area.

Three discoveries, which could total an estimated 80 million barrels of oil and 250 billion cubic feet of natural gas, were reported by Shell in the Tunu-1, Benin Estuary-1, and Ososo-1 concessions. Other discoveries were reported by Mobil in the Inuen-1 and Iyak-3 concessions; by Chevron Corp. in Ajapa 1; by Texaco in Ekeh-1; and by Elf Aquitaine near Elele.

By yearend, development work, at a cost of $375 million, had neared completion on Agip's Agbara offshore field. Production was scheduled in early 1989. The Agbara Field was anticipated to flow at a plateau of 40,000 bbl/d from a reservoir with estimated recoverable reserves of 65 million barrels. Development cost was relatively high at $5.75 per barrel.

Mobil continued development work on the Edop Field 25 miles offshore from Qua Iboe. By yearend, one platform was in operation with three wells producing a total of 20,000 bbl/d. The installation of five additional platforms was planned for an eventual output in excess of 150,000 bbl/d.

Mobil also initiated the development of the Oso condensate field 18 miles offshore Eket by awarding a preliminary engineering study contract to Fluor Corp. Recoverable reserves were estimated at 445 million barrels of condensate ranging from 48° to 52° API gravity. Field development will include seven offshore platforms for drilling and processing, 120 miles of pipeline, and onshore loading and storage facilities at Qua Iboe terminal. Recovery methods will include high pressure gas re-injection systems. The Oso Field is expected to yield 100,000 bbl/d in the first 5 to 7 years of production. The life of the field is estimated at 25 years.

The Nigerian National Petroleum Corp. (NNPC) will own and provide financing for 60% of the Oso Field project in partnership with Mobil. Mobil will provide 40% of the financing and will have total responsibility for technical expertise. In addition to marketing its own 40% share of Oso Field production, Mobil will market one-half of NNPC's 60% share for 5 years following project commissioning, which was scheduled for 1991. The World Bank affiliated International Finance Corp. was financial coordinator for the $900 million development of the Oso condensate field. Interest in condensate field development was augmented by the fact that production was not subject, at least at this time, to OPEC quotas and could be exported in quantities limited only by production capabilities and market demand. Furthermore, development cost at $2 per barrel was particularly favorable.

Production.—Crude oil and condensates production averaged 1.39 million bbl/d in January, dropping to the year's lowest level in April at 1.32 million bbl/d when prices increased to $16.75 per barrel for Nigeria's Bonny Light crude stream and $16.60 per barrel for Forcados crude stream. By August, production was 1.50 million bbl/d, compensating for reduced spot market prices for Bonny Light at $15.10 per barrel and for Forcados crude at $14.90 per barrel. In October, the spot market price dropped to $12.55 per barrel for Bonny Light and $12.45 per barrel for Forcados, while production increased to 1.55 million bbl/d. In December, production averaged 1.65 million bbl/d with the spot market price at $15.45 per barrel for Bonny Light and $15.35 per barrel for Forcados. Bonny Light crude stream at 37° API led production output through September, but took second place to the Forcados crude oil stream at 31° API during the elevated fourth quarter production level.

The Bonny Light and Forcados crude accounted for one-half of Nigeria's crude oil output. The Escravos 36° API crude and Qua Iboe 37° API crude each accounted for 15% of production. Bonny medium 26° API crude and Brass Blends 40° API crude each accounted for 8% of output. Pennington and Anton, both 36° API crudes, contributed the remaining 4% of production.

Refining and Marketing.—In support of the Government program to increase petroleum product exports, particularly to West African markets, and to limit the Nigerian offshore refining arrangements, a fourth refinery neared completion and was scheduled to be commissioned in May 1989. Adjacent to Nigeria's oldest refinery at Alesa-Eleme near Port Harcourt, the fourth refinery was designed to have a crude distillation capacity of 150,000 bbl/d. Built by Spie Batignolles (France), Japan Gasoline Corp., and Marubeni Corp. (Japan), the refinery was largely financed with loans guaranteed by export credit agencies amounting to $320 million from France and $280 million from Japan. The refinery is planned to have a direct link with the Bonny export terminals and storage facilities by 1990. In the interim, products are to be transferred by tank trucks and pipeline to Nigeria's southern and central States.

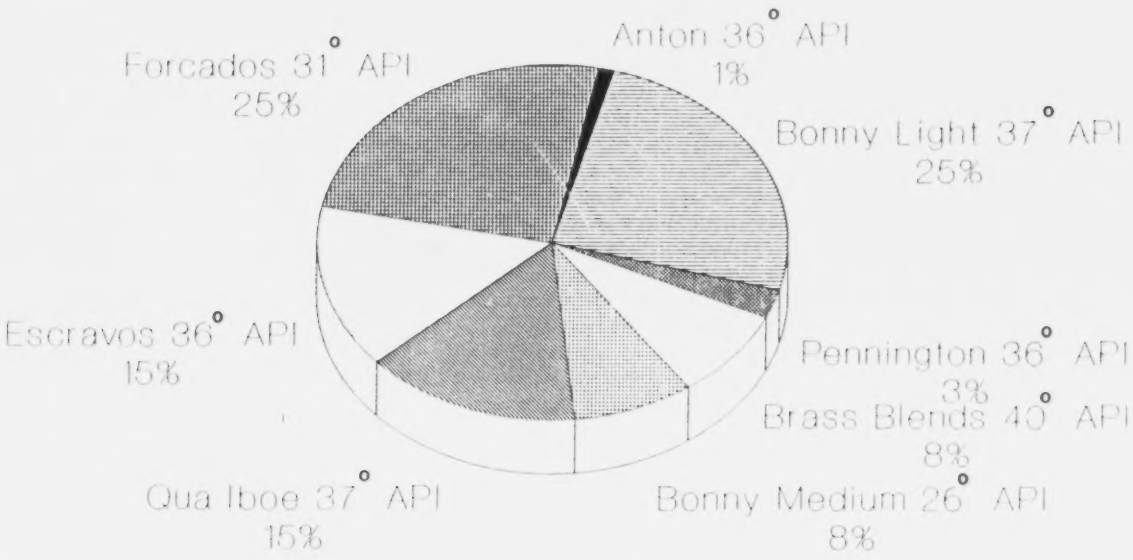
By yearend, expansion of the 100,000-bbl/d Warri refinery to a distillation capacity of 125,000-bbl/d was virtually completed. This raised Nigeria's total crude distillation capacity to 445,000 bbl/d, including the 110,000-bbl/d Kaduna refinery and both the 60,000-bbl/d original and the new 150,000-bbl/d Port Harcourt refineries. The Nigerian National Petroleum Corp. installed a 6,000-bbl/d Merox unit at the Kaduna refinery to increase production of liquefied petroleum gas (LPG) to 3,000 bbl/d, sufficient to meet domestic demands and release LPG production from the coastal refineries at Warri and Port Harcourt for export.

In 1988, Nigeria's three operating refineries averaged a total throughput of 175,000 bbl/d. The NNPC also assigned an estimated 45,000 bbl/d of crude oil for overseas processing under

FIGURE 2

NIGERIA—CRUDE PETROLEUM PRODUCTION IN 1988

(Total production = 1.45 million barrels per day)



Source: Nigerian Petroleum News.

contracts with Basic Resources (United States), Petrobras (Brazil), and Total S.A. (France). This included the return of light fraction products to the Nigerian market.

The NNCP negotiated at least six contracts involving an estimated total of 0.5 million bbl/d of crude oil sold to refiners in the United States and Spain based on a net-back formula determined by the market price of products. An integral component of the net-back agreements included discussions related to the Nigerian purchase of equity interest in the overseas refineries with payments in crude oil. For the first half of 1988, the net-back formula yielded a price $2 to $3 below the spot market sales. In the second half of 1988, the position of net-back contracts was reversed when spot market prices plummeted with the Middle East production in excess of OPEC quotas. Consequently, buyers demanded a review of the net-back formula.

Petrochemicals.—The NNPC petrochemical plants at Kaduna and Warri entered commercial production in March. This implemented Phase 1 of the petrochemical development program intended to promote import substitution and conserve foreign currency.

The Kaduna plant was designed to produce 30,000 tons of linear alkyl benzene annually and was reported op-

erating near capacity. The Warri complex was designed to produce 18,000 tons of carbon black and 37,000 tons of polypropylene annually. The carbon black plant operated at 60% capacity. The price of Warri-produced carbon black was competitive with the landed price of imports. However, only three of the five hard grades of carbon black utilized in tire manufacture were produced at Warri. This required Michelin Nigeria Ltd. to continue importing some grades of carbon black. Nigeria cannot widen its range of carbon black without additional heavy investment. Increased sales of the existing grades should improve with construction of a tire manufacturing plant in neighboring Benin. The polypropylene production unit was nonoperational for most of 1988 due to a breakdown in the fluid catalytic cracking unit that provided a vital catalyst for polypropylene production.

Phase 2 of the petrochemical development program was scaled down from the $4 billion complex originally proposed in 1986 to an $800 million undertaking centered at Eleme with plant capacity designed to produce 250,000 tons of polypropylene and 80,000 tons of polyethylene annually based on natural gas as feedstock. Nigerian 1988 consumption levels for these chemicals would absorb about 60% of production with the remainder intended for export during a 5-year period. At the end of this period, Nigerian demand is projected to rise to absorb the total output.

Preliminary design contracts for the Phase 2 project were awarded to Spie Batignolles (France), Technimont (Italy), and Chiyoda and Kobe Steel (Japan). Technimont and Chiyoda and Kobe Steel are considering equity partnerships with the National Nigerian Petroleum Corp. in the Phase 2 project. Financing for 85% of the project will be raised by equity partners.

Natural Gas.—Production of natural gas averaged 2 billion cubic feet per day. Output ranged from nearly 1.8 billion cubic feet per day in April to 2.2 billion cubic feet per day in December, paralleling crude oil output. Natural gas utilization ranged from 20% to 31%. More gas was flared in September and October as less gas was used for reinjection and other oilfield operations during those months. About 70% to 80% of natural gas continued to be flared because of the prohibitive cost of the required infrastructure for utilization. In an effort at utilization, the Escravos-Warri-Lagos 228-mile, 36-inch-diameter natural gas pipeline was commissioned in September. Initial flow of 265 million cubic feet per day was supplied to the Egbin power station serving Lagos. Construction of the Utorugu gas treatment plant owned by NNPC (80%) in partnership with Shell Petroleum Development Co. of Nigeria (20%) was completed by yearend. Gas entered the plant at 3,919 pounds per square inch guage. Six process trains reduced pressure, cooled the gas, and extracted water and condensate. Treated gas was delivered to the Lagos pipeline. This main line included a spur connecting the Oben gas plant, which supplied gas through a 124-mile, 24-inch diameter pipeline, to the Ajaokuta Steel Co. for direct reduction of iron ore. The spur line assures that gas will be supplied to the steel mill when Oben Field is depleted.

Nigerian plans for nonassociated natural gas development and utilization focused on the liquified natural gas markets of Europe and the United States east coast. Construction of a $2 billion plant on Bonny Island, utilizing the Technip/Snamprogetti Tealarc liquifation process, was proposed by NNPC holding 60% equity with Shell Gas BV holding 20% and Elf Aquitaine and AGIP S.p.A. each holding 10%. Natural gas sources proposed for the project were onshore reservoirs in the East Niger River Delta. Gas production costs were projected to be relatively low because the gas contained few impurities and only shallow drilling would be required. The project group entered into contract negotiation with at least five major gas distribution companies during the year: Ruhrgas, BEB, and Thyssengas of the Federal Republic of Germany; Enagas of Spain; and Snam Gas of Italy. The group expected to complete negotiations with buyers and arrange finance in time to award construction contracts in early 1991, initial shipment of liquefied natural gas in 1995, and attainment of plateau shipments of 4 million tons of liquefied natural gas annually by 1997.

SENEGAL[21]

The production and export of phosphates continued to dominate Senegal's mineral industry. Export earnings in 1988 from phosphates and byproduct attapulgite and clinker increased 23% to about $81 million.[22] Fertilizer exports decreased 6% to $62 million. These exports cumulatively accounted for more than 18% of the country's total export revenues. Total phosphate production increased 22%, despite increased production costs and lower sales to certain countries resulting from concerns about the high level of cadmium in the phosphate. In addition to phosphates and related products, Senegal exported $4.8 million in salt and about $605,000 in cement.

Société Minière de Sabodala, a joint venture between the BRGM (52%) and the Government, was predicting the startup of gold production at the Sabodala deposit by 1991, assuming a favorable outcome of discussions between the partners. The company managed to increase the reserves slightly, but it was felt that additional reserves would be needed for a favorable production decision.

Senegal adopted a new mining code in mid-August. The new law was an effort to consolidate and modernize provisions of the existing laws that had remained virtually unchanged for 25 years. Liberalization of the financial and temporal aspects of exploration and mining agreements were features of

the new law, which attempted to encourage mineral development both by local and international entities.

Toward yearend, the Government announced that it would host a major conference on hazardous wastes in late January 1989. The conference was to address the growing problem of foreign companies attempting to use West African countries as a dumping ground for such materials.

Commodity Review

Metals.—**Titanium.**—In October, E. I. du Pont de Nemours & Co. Inc. announced that they had signed an agreement with the Government covering exploration and potential mining of heavy minerals (ilmenite) beach sand deposits along the coast. The agreement, which had awaited the passage of Senegal's new mining law, provided for a 4-year exploration period with options for two renewals. Assuming that an ore deposit was found, the agreement granted Du Pont exclusive rights to mine the deposit for an initial 25-year period, renewable for another 25 years. The company stated that ilmenite production from Senegal would be sent to four of the company's TiO_2 plants in the United States and one in Mexico. The company expected to begin detailed sampling, at Pointe Sarene, south of Dakar, in January 1989. It was hoped that the deposit would be in production by the mid-1990's and that the output would be in excess of 100,000 tons of concentrate per year.

Industrial Minerals.—**Phosphates.**—Production of calcium phosphates by Compagnie Sénégalaise des Phosphates de Taïba (CSPT) increased 22% to 2.244 million tons. Exports increased almost 29% to 1.774 million tons, and export revenues increased 36% to $69.7 million. The main destinations of CSPT ore were the Philippines (31.4%), India (17.8%), the United Kingdom (10.3%), Greece (10.1%), and France and Spain (8.8% each). Overall sales to the European Community (EC) appeared to have been hurt by the high cadmium content (averaging 75 parts per million) of the ore, justifying concerns in the previous year for the future of such sales. Local sales of 551,000 tons, worth $13.4 million, were largely to Industries Chimiques du Sénégal (ICS), a fertilizer manufacturer.

Production of aluminum phosphate by Société Sénégalaise de Thiès (SSPT) decreased almost 38% to 119,300 tons. Exports, all to France, decreased about 8% to 42,370 tons, but export revenues fell almost 42% to $676,000. Clinker export revenues fell 31% to $3.55 million. In contrast, calcium phosphate production by SSPT more than doubled, to 81,580 tons. Exports, mostly to France and Greece, increased by two-thirds to about 78,000 tons, worth $1.9 million. The company also produced attapulgite, production of which fell slightly to 108,425 tons. Attapulgite export revenues fell 20%, to $4.66 million. Senegal was trying to expand its export market for aluminum phosphate and was especially interested in markets in Thailand, Pakistan, and China.

Export revenues for fertilizers produced by ICS decreased slightly to $62.1 million. Fertilizer sales were mostly to India, France, and Senegal's neighboring countries.

Mineral Fuels.—The Société Africaine de Raffinage, Senegal's sole refinery, increased its output 23% to 5.4 million barrels of crude oil. This amount was about 50% of capacity. The refinery processed about 20,000 barrels of liquid hydrocarbon distillate from the country's gasfields, in addition to the crude oil, which was imported from Nigeria (57%), Gabon (31%), and Angola (12%). Refinery output was affected by a 6-week shutdown for maintenance purposes and by reduced demand from customers Mali and Guinea-Bissau.

Following the completion of a high-resolution seismic survey in February, Ireland's Tullow Oil Plc. commenced a four gas well drilling program in an attempt to increase production from the Kabor and North Diam Niadio gasfields northeast of Dakar. The fields had been placed into production by France's Societé Nationale Elf Aquitaine, but Elf had dropped its concession in 1980, at which time production ceased. Tullow expected to increase production from existing wells to 1 million cubic feet per day by yearend and hoped that the new wells would boost production to 3 to 5 million cubic feet per day. By yearend, two of the wells had been completed. Existing gas production of 500,000 cubic feet per day was burned in a power station 18 kilometers from Dakar and was transported to the power station by a pipeline that had been refurbished by Tullow and the Government, using World Bank funding.

SIERRA LEONE[23]

The production and export of mineral commodities had traditionally sustained Sierra Leone's economy. In recent years, heavy revenue losses attributed to illegal trading contributed to the country's balance of trade deficits in excess of 10% of the GDP. In an effort to reverse this situation a new mining policy was promulgated focusing on the gold and diamond industry. The main thrust of the policy limited license awards to miners with proven sufficient capital and expertise to effectively mine the property.

Under the new policy, the Ministry of Mines was empowered to periodically inspect production records and to determine the quantities and frequency of sales. Dealers were required to either export an average of $500,000 worth of gold or diamonds monthly or have their licenses revoked. Exporters were required to repatriate 60% of their hard currency earnings to the Central Bank of Sierra Leone. To encourage participation, the Government released and recommended for investment several

promising gold and diamond mining properties throughout Sierra Leone. The success of the mining policy was yet to be determined but it at least provided a framework for curbing illicit trading and channeling the much needed additional funds to the Central Bank.

The large Government deficit was financed by money creation with the following results: the money supply virtually doubled in 1985, doubled again in 1986, and increased 50% in 1987 and the first three quarters of 1988 with the last quarter remaining constant. In January 1988, the Leone was valued at 45 to the dollar. In April, the Leone was devalued to 65 to the dollar; a rate closer to the 75 Leone to the dollar exchange of the black market and a further disincentive for illicit trading.

The Government, in collaboration with the World Bank, was engaged in developing a comprehensive mining investment code aimed at stimulating private investment in the Sierra Leone mining industry.

Production and Trade

The value of Sierra Leone's mineral exports was estimated at $80 million in 1988, equal to over 70% of total exports for the year.[24]

Rutile continued to be the nation's principal mineral export. The 1988 record production of 126,000 tons, which was valued at $43 million, was exported to Western Europe and the United States. Although diamond exports have traditionally ranked second as the nation's foreign exchange earner, the emergency measures adopted to curb illicit trading in late 1987 and 1988 temporarily reduced official exports to $4.3 million or 18,000 carats. Bauxite production and exports consequently ranked second, earning $22.4 million.

Commodity Review

***Metals.*—Bauxite.**—The Sierra Leone Ore and Metal Co., the nation's sole bauxite producer, completed the $2 million Mokanji Mine expansion program that began in 1987. A second bauxite operation and an alumina plant were planned for development at Port Loko.

Gold.—The illegal mining and consequent smuggling of gold prompted the Government to adopt emergency measures in November 1987, requiring that all gold be sold to the Central Bank of Sierra Leone, which was recognized as the sole legal exporter. Licenses to mine, trade, and export gold were withdrawn from 340 small-scale miners, 200 gold dealers, and 50 exporters. Licenses were issued only to investors with sufficient capital and expertise to conduct gold exploration, with emphasis on exploration in the Mototoka, Lake Sonfon, and Gori Hills regions.

Additional legislation was enacted in 1988 and modified in early 1989, which revoked the ban on mining and export licenses. Domestic gold-mining companies applying for licenses were required to hold working capital of $100,000 and companies with foreign shareholders were required to hold $125,000.

To create a climate for legal participation in Sierra Leone's gold-mining industry, the Government opened to local prospectors gold-mining areas in Pampana, Tane Chiefdom, Kalmaro, Kafe Simira, Sanda Loko, Bombali, Kunife, Valunia, and Simbaru. Licensees would be required to keep accurate production records, which would be subject to periodic inspection by the Ministry of Mines, and would be required to sell to exporters such quantities of gold as may be determined by the Ministry. Failure to comply with these sales requirements would result in loss of license.

Gold traders were required to purchase licenses annually at a cost of $5,000 for foreigners and $2,500 for nationals. Traders would be permitted to retain 40% of export earnings with 60% to be repatriated to the Central Bank of Sierra Leone at the official exchange rate. Performance standards were set at an average of $500,000 worth of gold exports monthly. Failure to meet this standard would result in loss of license. Gold exporters were also required to pay a royalty at the rate of 1.5% of the exported gold's value to cover administrative charges.

Iron Ore.—Production from the Marampa Mine ended in 1985 because of very poor world market conditions. However, the Ministry of Mines concluded an agreement in 1988 with two French firms to conduct a feasibility study of the mines and assess the potential and economic viability of the Marampa region, an area about 80 kilometers east of Freetown.

Titanium.—In 1988, rutile production from Sierra Rutile Ltd., which was a wholly owned subsidiary of Nord Resources Corp. of the United States, attained a record level of 126,000 tons containing 96% titanium dioxide. Byproduct ilmenite production from a new plant, which was commissioned in late 1987, totaled 42,000 metric tons containing 60% titanium dioxide. The sharp increase in production resulted from an expansion program and was at least partially attributable to the introduction of a Neumann bucket wheel secondary dredge. The bucket wheel was used as a reclaimer to recover dry mined material from outlying deposits and hauled to the dredge pond. It permitted selective mining in higher grade ore and also permitted the recovery of material that would not be minable by conventional dredging. In late 1989, Sierra Rutile Ltd. was to shift mining operations from the Bamba-Belebu deposit to the Pejebu ore body, which is 4 kilometers to the south. Ore reserves exposed in prospect pits and outlined by close-spaced drilling were 215 million tons averaging 1.5% rutile. In 1988, Sierra Rutile Ltd. and the Government began negotiations on a new concession agreement.

Interest in developing titanium dioxide bearing mineral deposits near Roti-

funk, about 60 kilometers southeast of Freetown, was expressed by Intercontinental Gold and Minerals NL and MC Mining NL of Australia. Upon development, mining operations were expected to yield 56,000 tons of rutile, 83,000 tons of ilmenite, and 600 tons of zircon annually.

Industrial Minerals.—**Diamonds.**—In an effort to maximize Government earnings and to reduce the level of illicit trading, the Government adopted emergency measures in late 1987 calling for the withdrawal of all diamond export licenses and requiring producers to sell diamonds to the Government. By mid-1988, the Diamond Corp. of West Africa, a subsidiary of DeBeers' Central Selling Organization, reportedly ended its more than 30-year operation in Sierra Leone.

As the Government's diamond mining policy took form, additional legislation was enacted in 1988 and modified in early 1989. It revoked the ban on diamond export licenses, allowing traders to retain 40% of export earnings while requiring that 60% be repatriated to the Central Bank of Sierra Leone at the official rate. Licenses were to be granted to 25 dealers who were required to post a $500,000 performance bond. The dealers also were required to export an average of $500,000 worth of diamonds each month or risk losing their export license.

In accordance with the new policy, any applicant for a diamond mining license would have to provide proof of sufficient capital and expertise to effectively conduct the mining operation. Licensees would be required to keep accurate production records subject to periodic inspection by the Ministry of Mines. Licensees would be expected to sell to a dealer or exporter such quantities of diamonds as would be determined by the Minister of Mines. Failure to comply with these sales would result in loss of license. To protect the lease area of the state-owned National Diamond Mining Co. (NDMC), all diamond dealers in the area were obligated to engage in cooperative mining. Other specific mining areas have been released for alluvial diamond mining companies in Garrama Mande, Makpele, and Wando Nomo to create a climate for legal participation in the industry.

The National Diamond Mining Co., in a joint venture with Outokumpu Oy of Finland, scheduled mining operations to begin in 1989 on two pipes and numerous kimberlite dykes at Kono. Capital cost of the first phase of development was estimated at $30 million; the cost of the second stage was projected to be $40 million. Initial output was estimated at 54,000 carats annually and was expected to rise to 250,000 annually after 8 years of operation. Possible financial support for the project included the Kuwait Fund for Arab Economic Development and the Kuwait Investment Fund.

To improve existing diamond mining operations, the Ministry of Mines signed an agreement with Sumatu Raygreen Mining Co. (Sierra Leone), which obligated the latter to loan $4 million to NDMC to enable the national company to rehabilitate and modernize its mining equipment.

Mineral Fuels.—**Petroleum.**—The Sierra Leone Petroleum Refining Co. of Freetown operated a 10,000-bbl/d capacity refinery based on imported crudes. Crude suppliers have been Nigeria and Iran, but overdue obligations have prompted Sierra Leone to seek a new supplier. Libya signed an agreement in April supplying not only petroleum but also including investments in agriculture, mining, and fishing.

Petroleum product prices have been considerably lower in Sierra Leone and often were less than one-half the price the product commanded in neighboring countries. To discourage massive smuggling of fuel into these countries, petroleum product price increases were scheduled for mid-1989. Gasoline prices would be doubled from $.75 to $1.50 per gallon.

TOGO[25]

Togo's mineral industry continued to be dominated by the production and export of phosphates. Phosphate production increased significantly in 1988, and phosphate exports accounted for about 50% of the country's total export revenues. Cement and marble production increased, as did the production of steel.

In September, the Government approved a new environmental code prohibiting the importation, sale, storage, or transshipment of toxic wastes in the country.

Commodity Review

Metals.—**Steel.**—Togo's only steel company, the Société Togolaise de Sidérurgie, a producer of rebar since 1984, was undergoing a $2 million expansion of its product line to include electric power pylons, and galvanized steel frames for industrial buildings. Output of these new products was expected to reach 3,000 tons per year by 1990.

Industrial Minerals.—**Cement.**—Production by the country's sole cement producer, Les Ciments du Togo, increased slightly in 1988 to about 377,800 tons. Production relied entirely on imported clinker. Total reported cement sales were about 270,000 tons, of which, 39% was exported.

Marble.—Marble production by Nouvelle Société Togolaise de Marbrerie et de Matériaux more than doubled as a result of improvements made since the company was restructured in late 1986. However, production was still less than one-third the reported output capacity of 250 square meters per day.

Phosphates.—Phosphates remained Togo's main mineral resource. As predicted in 1987, environmental concerns over the high cadmium content, aver-

aging 55 parts per million, of Togolese phosphate resulted in a loss of sales to certain traditional major buyers in the EC, notably the Netherlands. In this respect, the EC's share of Togolese phosphate exports fell from 90% in recent years to about 30% in 1988. However, Togo was able to more than offset this reduction by securing major contracts with new customers, with the result that phosphate production increased significantly to a record level of about 3.5 million tons. Phosphate export revenues were about $336 million.[26] The largest new long-term contract was to supply about 1 million tons per year to Esso's Redwater plant in Canada. Other new customers included Cyprus, India, the Philippines, and Poland. Togo also benefited from very high prices received for its phosphates.

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[1] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[2] Where necessary, values for Benin have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00. The conversion rate for 1987 was CFAF302 = US$1.00.

[3] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[4] Where necessary, values for Burkina Faso have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00.

[5] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[6] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[7] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[8] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[9] Where necessary, values have been converted from Ghanaian cedis (C) to U.S. dollars at a rate of C202.4 = US$1.00

[10] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[11] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[12] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[13] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[14] Where necessary, values for Mali have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00.

[15] Prepared by Bernadette Michalski, mineral specialist, Division of International Minerals.

[16] Where necessary, values have been converted from Mauritanian ouguiya (UM) to U.S. dollars at the exchange rate of UM76.0 = US$1.00.

[17] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[18] Where necessary, values for Niger have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00.

[19] Prepared by Bernadette Michalski, mineral specialist, Division of International Minerals.

[20] Where necessary, values have been converted from Nigerian nairas (N) to U.S. dollars at the rate of N5.03 = US$1.00 in 1988.

[21] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[22] Where necessary, values for Senegal have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00. The conversion rate for 1987 was CFAF302 = US$1.00.

[23] By Bernadette Michalski, mineral specialist, Division of International Minerals.

[24] Where necessary, values have been converted from leones (Le) to U.S. dollars at the rate of Le65 = US$1.00.

[25] Prepared by Hendrik G. van Oss, physical scientist, Division of International Minerals.

[26] Where necessary, values for Togo have been converted from Communauté Financière Africaine francs (CFAF) to U.S. dollars at the rate of CFAF298 = US$1.00.